DYNAMICS IN TEAM-BASED KNOWLEDGE WORK: UNDERSTANDING PROCESSES AND MEDIA USE.

by

NICLAS L. ERHARDT

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ABSTRACT OF THE DISSERTATION

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by NICLAS LEIF ERHARDT

Dissertation Director:
Charles Heckscher

Teams are fundamental mechanisms to create and mobilize knowledge in the workplace. Yet, our understanding of the internal processes that govern the manner in which teams create and mobilize knowledge remains limited. Drawing on 102 interviews (over 65 hours of recorded data) and archival data such as team observations, over 400 emails between team members, and documents in six team projects in the USA and Sweden from pharmaceutical, insurance and engineering companies, I build a grounded theory of team-based knowledge work. The theory delineates three key knowledge processes that constitute the notion of team-based knowledge work – knowledge sharing, knowledge creation and team learning. This theoretical framing is then further explored in the context of task complexity, distributed knowledge, interdependence, media use and political dynamics in teams. Theoretical and practical implications are addressed.

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DEDICATION

To my Mother:

I love you!

I miss you!

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CHAPTER 1

INTRODUCTION: THE KNOWLEDGE PARADIGM

Knowledge has become a key factor for companies to create and maintain a competitive edge in a rapid growing knowledge economy (Kogut & Zander, 1992; Grant, 1996; Machlup, 1962; Porat, 1977; Rubin & Huber, 1986; Powell & Snellman, 2004). This on-going growth of knowledge in the workplace has a profound impact on traditional organizational structures (Burns & Stalker, 1961; Osterman, 1994; Drucker, 1999). Organizations that compete on knowledge are currently undergoing a shift from bureaucratic structures, characterized by fixed roles with clear responsibilities, towards more collaborative knowledge intensive firms where vertical and horizontal reporting relationships are blurred and teamwork is critical (Kanter, 1989; Alvesson, 2004; Lindbeck & Snower, 2001; Heckscher & Donnellon, 1994; Heckscher & Adler, 2006).

This shift towards more complex team-based organizations with an emphasis on knowledge production can be attributed to two related environmental forces: the on-going globalization and information technological advancements. The growing globalization has a profound impact on business models and strategies. No longer are competitors located within close proximity and faced with similar labor markets but are now dispersed across the globe. Companies operating in low-cost regions are continuously finding ways to out-price competitors in other regions. The shrinking profit margins for companies that traditionally relied on commodities continue to spur more competition. Companies such as IBM find themselves at a crossroad having to re-think their business strategies to focus on knowledge production in order to compete.

Perhaps an equally strong force that has contributed to the emphasis on knowledge production is the proliferation of information technology (IT). The increase use of IT has not only a significant impact on workplace arrangements but is also dramatically

changing companies' relationships with their customers. With the ease of a few clicks, customer knowledge of current trends, price and product availability has radically changed companies' mode of operations. In many industries it has become more difficult to simply produce and sell products and companies are finding themselves scanning the dynamic market to predict and respond to customer demands. As a result, profitability in the emerging knowledge-driven market place is to a large extent contingent upon the speed to create, adjust, and deliver cutting edge products and solutions.

Taken together, the on-going globalization and IT advancements shape new forms of workplace arrangements moving away from manual of physical work towards abstract and conceptual interdependent teamwork facilitated in part through virtual means. Scientific management, spearheaded by Taylor, attempted to reduce the knowledge held by employees by breaking down the job into the smallest components to assure that the knowledge rested in the hands of the managers. However, separating knowledge from the actual work is no longer feasible or effective since the work itself many times is unspecified, operates on the edge of what is known, requires a great deal of discretion, and where the path to the end goal is not always clear (Mohrman, Cohen & Mohrman, 1995). Knowledge is now increasingly pushed down from top management to the minds of empowered employees that must think, develop and implement solutions and ideas at their own discretion.

In turn, the emphasis on knowledge has also created greater interdependence in terms of teamwork in the workplace (Heckscher & Adler, 2006; Drucker, 1992; Mohrman, Cohen & Mohrman, 1995; Grant, 1996b). This interdependence is rooted in increased specialization in the workplace (Adler & Heckscher, 2006). The onslaught of knowledge requires individuals to hold more advanced degrees, master a greater knowledge base and

stay informed about the latest technological advancements in order to carry out one job and keep up with global competition. This specialization now requires greater reliance on other individuals within and across functions holding different but complimentary knowledge. As a result, organizations are adopting teamwork structures to better leverage and integrated individual expertise necessary to solve complex problems (McDonough, Kahn & Barczak, 2001).

As the use information technology continues to advance, virtual interaction is a critical aspect to foster and promote interdependent knowledge work in teams. Working through virtual interaction is typically viewed as means adopted by geographically dispersed teams (Kirkman & Mathieu, 2005). However, co-located teams that can meet face-to-face (FtF) on a regular or daily basis (i.e. located in the same building or site) are increasingly relying on email, phone and FfF interaction to conduct knowledge work. Yet, despite the overwhelming consensus among scholars and practitioners regarding knowledge as key strategic resource, the interplay between FtF and virtual interaction and their implication for knowledge work remains largely unexplored and deserves more attention (Kirkman et al. 2004).

Three Chapters

The dissertation is structured into three essays (chapters) that together constitute my dissertation. Using a qualitative case-based research approach, my dissertation contributes to the emerging knowledge work literature in three distinct but related ways. In the first essay, I explore and flesh out the proverbial black box of the *process* of teamwork in the context of knowledge. Specifically, I identify three central knowledge processes – *knowledge sharing*, *knowledge creation* and *team learning* – that together represent team-based knowledge work (TBKW). Each of the process is investigated and

the relationship among them is explained. In the second essay, I consider the form that these processes take in different types of knowledge team, and delineate a conceptual framework to categorize teams according to the complexity of the problem faced by the team and the level of distributed knowledge needed to carry out the task. In the final essay, I further explore the complex mix of knowledge processes and political dynamics or strategic ambiguity and status differentials and their implications on media use to conduct TBKW.

Method. I adopted a qualitative case-based approach in order to explore the dynamics in different types of team-based knowledge work. The bulk of the data was captured via a total of 102 interviews (92 hours of recorded data) along with supplemental data such as team observations, 408 emails between team members, observations and documents, team charts, and presentations. Moreover, I collected data from six project teams (projects include: Green light, E-letter, Start, Wheelbase, Powerbox and APO) in various stages from companies operating in Sweden (a large insurance company and a small engineering company) and in the US (one pharmaceutical company and a large consumer health product company) during 16th months of fieldwork. Each of these three essays is presented below in subsequent order. The final chapter (chapter 5) I integrate my work and summary of the findings across all three studies

CHAPTER 2

IT'S TIME FOR A STAKE IN THE GROUND: A FRAMEWORK FOR TEAM-BASED KNOWLEDGE WORK

ABSTRACT

Teams are fundamental mechanisms to create and mobilize knowledge and understanding the processes involved in knowledge work in the team context is critically relevant. However, while scholars have identified various potential knowledge processes such as knowledge sharing, knowledge creation and learning, each process is typically studied separately and at times confused with one another. In an attempt to provide clarity, this study provides a framework that integrates these processes. By adopting a grounded approach, I conducted 88 semi-structured interviews over a 15-month period to explore the notion of team-based knowledge work in four companies in Sweden and in the US. A framework of team-based knowledge is outlined that differentiates and explains the relationship among key knowledge processes. Theoretical and practical implications are addressed and future research directions are outlined.

Key words: team-based knowledge work, knowledge sharing, knowledge creation, team learning

Knowledge has become a key factor for companies to create and maintain a competitive edge in a rapid growing knowledge economy (Kogut & Zander, 1992; Grant, 1996; Machlup, 1962; Porat, 1977; Rubin & Huber, 1986; Powell & Snellman, 2004). As organizations reorganize to better create and integrate knowledge, the nature of work is changing as well. This emerging new form of work is commonly referred to as knowledge work (Drucker, 1999; Davenport, 2005). Scholars concerned with knowledge work have typically viewed it as an occupation practiced among a well-educated group of professionals involved with highly cognitive abstract work on an individual basis (Davenport, 2005; Alvesson, 2004; Senge, 1990; Choi & Varney, 1995). However, limited attention has been paid to knowledge work as a team process that transcends professional occupations.

Conceptualizing knowledge work as a team process acknowledges how work is increasingly structured in knowledge intensive firms (Heckscher & Donnellon, 1994; Heckscher & Adler, 2006; Mohrman, Cohen & Mohrman, 1995; Blasi & Kruse, 2006). Firms that compete on knowledge are undergoing a shift from bureaucratic structures, characterized by fixed roles with clear responsibilities, towards more complex knowledge-intensive firms where vertical and horizontal reporting relationships are blurred and teamwork is critical (Alvesson, 2004; Lindbeck & Snower, 2000; Heckscher & Donnellon, 1994; Wageman, 1995).

Teams are a key mechanism to leverage and mobilize knowledge (Kanter, 1987; Senge, 1990; Grant, 1996; Edmondson, 1999; Gilson & Shalley, 2004; Lawrence & Lorsch, 1969; Rubinstein, 2000). What distinguish teams involved in knowledge work from other forms of teamwork are the knowledge processes linked with the work itself. Grant (1996, 1996b) referred to these teams as “knowledge integrators” which may occur through

interactions between team members. Along similar lines, Mohrman, Cohen and Mohrman, (1995) pointed out the importance of teams in knowledge work as knowledge creating mechanisms where task interdependencies and perspectives can be worked out and constant learning is required since much of the work is on the edge of what is known. The notion of team-based knowledge work (TBKW) is adopted here to describe this collaborative process. This process may occur in different types of teams in terms of structure such as self-directed work teams (Hackman, 1990) and quality circles (Meyer & Scott, 1985). What characterizes knowledge work in teams is the temporary nature of a project where members are brought together based on their individual know-how relevant to the task at hand. Thus, the focus here is on project teams. These types of teams provide a clear start and end point during a finite length of time involved with a specific problem. More importantly, knowledge-intensive firms are increasingly adopting project teams where members from different functions are brought together to leverage and mobilize their individual knowledge to address a shared problem (Heckscher & Adler, 2007). Cohen and Bailey (1997: 242) summarized project teams nicely:

> "…time-limited…for the most part non-repetitive in nature and involve considerable application of knowledge judgment, and expertise. The work that a project team performs may represent either an incremental improvement over an existing concept or a radically different new idea."

Yet, limited research has explored knowledge work in project teams which makes them a pressing issue to better understand, especially for companies that compete based on knowledge (Zack, 1999).

While scholars have explored a range of team processes that may conceptually be linked with team-based knowledge work (for reviews see Marks, Mathieu & Zaccaro, 2001; Rousseau, Aube & Savoie, 2006), research on knowledge work is marked by

increased confusion. Within the general management field, knowledge work is frequently coupled with organizational learning (OL), which incorporates knowledge work among individuals, teams and larger units. The notion of OL stems from the analogy that social units such as teams and organizations can learn much like a single organism (Maier, Prange, & von Rosentiel, 2001) and has typically been used as a conceptual umbrella in research on knowledge work but is marked by increased confusion and complexity (Senge, 1990; Dierkes, Antal, Child, & Nonaka, 2003).

The aim here is provide more clarity around the notion of team-based knowledge work, that is, to build on the extant knowledge literature and to develop a grounded framework of team-based knowledge work that identifies, distinguishes and links key knowledge processes. Without such a framework, research on knowledge work in teams will likely be characterized by increased confusion and sluggish progress that will offer limited contributions to academicians or practitioners in the management field concerned with understanding and predicting effectiveness in team-based knowledge work.

In order to shed light on this phenomenon, and to put a stake in the ground as to what team-based knowledge work entails, I explored this concept during 15 months of fieldwork in various project teams through 88 semi-structured interviews in different companies. The paper is organized by first outlining the notion of knowledge and reviewing variations to approach it. Next, I discuss the notion of knowledge followed by contrasting knowledge workers and knowledge work as process.

CONCEPTUAL BACKGROUND

There is little doubt that knowledge has the potential to create and maintain a competitive edge and this has been well articulated elsewhere (Grant, 1996, 1996b).

Knowledge is what lays the foundation for any knowledge work to occur, which requires attention before discussing the notion of TBKW.

Knowledge. Philosophers reaching back centuries such as Plato and Descartes to more contemporary thinkers such as Foucault and Derrida have grappled with the question of what knowledge is. Scholars in the general management field continue to wrestle with this question and have approached it in various ways in the attempt to reach an acceptable definition. Nonaka (1994) defined knowledge as justified true belief. As such, knowledge in the organization can be viewed as gospel and taken for granted as "a way we do business here". Davenport and Prusak (2000: 2) provided a more concise definition, by order of complexity, and they separated data, information and knowledge into distinct categories. They argued that "…data is a set of discrete, objective facts about events" whereas information "…[is] a message, usually in the form of a document or an audible or visible communication". Knowledge incorporates these two components but is "…broader, deeper, and richer than data or information" and draws on experiences and values that originate in the mind of the knower. Alvesson (2004: 42) echoed Davenport and Prusak's definition by suggesting that knowledge can be "...used to embrace information (the simple, fragmented kind of knowledge), knowing (how to do), explanation (knowledge answering the question of 'why?', 'what is behind?', 'what is the cause?'), and understanding (knowledge referring to patterns, connections, providing the gestalt of a phenomenon)." Both Alvesson (2004) and Davenport and Prusak (2000) pointed out that knowledge involves experience and understanding. Without understanding, knowledge has no inherent meaning and is simply viewed as data at best. This understanding can be acquired by academic intellectual training or by practical experience.

Types of Knowledge. Another approach to reach a definition has been put forth by demarcating taxonomies of knowledge. Kogut and Zander, (1992) viewed knowledge as "know-how" or knowing how to do something and as "information" or what something means. In a similar vein, Bock, Zmud, Kim, & Lee, (2005) approached types of knowledge from a more practical aspect and viewed knowledge as know-how, know-when and know-who, which is echoed in the transactive memory literature (Wegner, 1989). Balconi (2002) made the distinction between perceptual knowledge and technical knowledge such as how to operate a machine. Underlying these views is the notion of tacit and explicitness of knowledge or what Alvesson (2004) referred to as "knowledge" vs "knowing." That is, knowledge that is truly objective such as the three angles adding up to 180 degrees necessary to constitute a triangle or knowledge that cannot be readily separated from the knower such as hints or intuitions.

The tacit-explicit distinction has been an influential approach in research on types of knowledge and is attributed to Polany's (1966) seminal work on the *Tacit Dimension*. Polanyi's (1966: 4) frequently cited phrase "…we know more than we can tell" captures the central point – individuals may have the knowledge to carry out a task (e.g. riding a bike) without necessarily being able to fully explain the process. Nonaka and Takeuchi (1995) brought the tacit-explicit notion into the general management field in their theory of the knowledge creation spiral. They discussed how knowledge is shared and created through interactions in an on-going circular process referred to as a knowledge spiral.

The discussion above illustrates the fact that the construct of knowledge is not straightforward or easily defined and is inherently unobservable, which is what makes it challenging to address in empirical research (Argote & Ingram, 2000; Schoonhoven, 2002). Thus, for knowledge to be a useful concept in this discussion, a definition should

include the notion of tacit-explicitness as noted by Polanyi (1966) and the issues of understanding and experience as Davenport and Prusak (1998) and Alvesson (2004) pointed out above. With the risk of grossly oversimplifying, knowledge is broadly defined here as *understanding gained by intellectual and/or practical experience that can vary in tacitness and types*, and is the foundation for any knowledge process involved in team-based knowledge work. For example, a person may have gained intellectual knowledge by completing a management degree from a university. Another person may have obtained practical knowledge via years of working in a marketing function. Both persons hold a knowledge base – one being more theoretical and the other more practical – yet both may be important in team-based knowledge work.

Knowledge Work

Scholars discussing knowledge work commonly fall short of explaining the specifics as to what it actually entails. More often, scholars focus on the professions that are involved in knowledge work and the context they operate in, which is to a large extent determined by the knowledge strategy of the firm (Zack, 1999). Alvesson (2004) referred to these companies as knowledge-intensive firms (KIF) and outlined characteristics of work carried out in these firms. Specifically, he suggested that knowledge work in KIF is characterized by 1) self-organization and dispersed authority, 2) a tendency to downplay bureaucracy in favor of ad hoc organizational forms; 3) a high level of uncertainty and problem-awareness in team work calling for extensive communication for coordination and problem solving; and 4) complex problems and solutions involving considerable elements of intangibility, calling for subjective and uncertain quality assessment.

While Alvesson (2004) provides a useful discussion of the context of knowledge work and hints at the importance of teamwork, a central question is whether the act of working with knowledge is confined to a cluster of occupations (e.g. Choi & Varney, 1995; Lepak & Snell 1999), or individual characteristics (e.g. Tampoe, 1993) or if it simply is a mode of work that virtually all employees could be involved with to some degree. Scholars focusing on this issue explicitly or implicitly view knowledge work as an occupation and commonly use it interchangeably with professionals (Davenport, 2005; Senge, 1990). However, Kelloway and Barling (2000) argued that all employees work with knowledge to some degree and that knowledge work should not be perceived as an occupation or group of professionals, but rather, a dimension of work – teamwork. That is, employees may be engaged in team-based knowledge work, in addition to their regular individual responsibilities. Wageman (1995) used the notion of hybrid teams to describe this dual work structure and illustrated this point by an example of a group of scientists in a development laboratory who on the one hand pursue independent research projects and on the other hand are part of a shared enterprise.

Building on these arguments, I explore the notion of knowledge work as a social process. I do not suggest here that knowledge work only occurs as a team phenomenon since it clearly exists as an individual phenomenon (i.e. among nurses, doctors, lawyers, scientists, engineers etc) and has been discussed elsewhere. What I am arguing, however, is that knowledge work in knowledge intensive firms commonly adopts team-based work structures in the form of projects to organize work and needs to be addressed as a social process (Heckscher & Adler, 2006). Shedding light on the internal processes of knowledge work in the team is needed to organize and structure this field of research concerned with teams in knowledge intensive firms.

Knowledge Work as Team Process

The general knowledge management (KM) field is commonly framed as being concerned with generating, storing, distributing, and applying knowledge (Vorbeck & Finke, 2001). However, the focus on knowledge raises both practical and methodological challenges given the many types and forms of knowledge, as discussed above. A more suitable approach to study knowledge work is to focus on the actual processes. Knowledge processes can be studied in various project teams in different industries regardless of the nature of the problem the teams face.

Research that explicitly or implicitly discuses knowledge work as a team process is characterized by confusion and remains poorly integrated. Part of the confusion is rooted in the use of the notion of "team process." Teamwork, the process that describes how the team is carrying out the task, can be defined as "members' interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioral activities directed towards organizing task work to achieve collective goals" (Marks, Mathieu & Zaccaro, 2001: 357). Marks and his colleagues made important distinctions between teamwork process, task work and emergent states. Whereas teamwork describes *how* the team is performing the task together, task work represents *what* it is the team is engaged in (e.g. designing a machine). Of course, task work is important for team effectiveness but it is guided and aligned by the team processes. The large literature on emergent states focuses on psychological issues as indicated in Gully, Incalcaterra, Joshi, & Beaubin's (2002) meta analysis. They concluded that motivational, cognitive and affective states are essential for team effectiveness. Marks and colleagues (2001) called them emergent states given their mutable characteristics (e.g. cohesion, motivational affective states), which are the products of team experiences. This is an important point to distinguish – emergent

states are very different from teamwork since they do not describe how the team interacts (see Srivastava, Bartol & Locke, 2006 for an empirical comparison).

Focusing specifically on teamwork processes, Marks et al., (2001) in their comprehensive review identified four action oriented processes: (1) monitoring progress towards goals, (2) systems monitoring, (3) team monitoring and backup behavior, and (4) coordination, all of which can be conceptually related to knowledge work in teams. A more recent review by Rousseau, Aube and Savoie (2006) noted some overlap of teamwork processes including 1) collaborative behaviors (coordination, cooperation, information exchange), and 2) team adjustment behaviors (backing up behaviors, intrateam coaching, collaborative problem solving, team practice innovation). Some of these processes are clearly related to knowledge work. However, while cooperation and coordination are processes involved in knowledge work in teams, they do not explain all activities related specifically to knowledge work.

Within the stream of research focusing specifically on work processes scholars have identified knowledge work processes such as team adaptation (Lepine, 2003), knowledge sharing (Bock & Kim, 2002; Zarraga & Bonache, 2005; Argote, McEvily & Reagans, 2003), knowledge creation (Gilson & Shalley, 2004; Leenders, van Engelen, & Kratzer, 2003; Argote et al., 2003), and team learning (Edmondson, 1999; Kozlowski, Gully, Nason, & Smith, 1999). However, little attention has been put forth to distinguish between them and they are often confounded with one another. For example, knowledge sharing is commonly linked with some form of managerial mechanism and outcome without considering knowledge creation as a related process (e.g. Bock et al., 2005). That is, knowledge sharing by itself does not provide much insight in itself as to the overall process of TBKW. Zarraga and Bonache (2005) treated learning as a form of knowledge

sharing and knowledge creation without acknowledging their differences. Edmondson (1999) combined all three processes in her conceptualization of team learning. The point here is not to criticize these early attempts, but rather acknowledge their valuable contributions and to further advance and sharpen our understanding about team-based knowledge work. I take a grounded theory approach to identify and explore core knowledge processes to better understand their relationships. A qualitative approach is well suited for exploring new contemporary concepts that are grounded in the workplace (Miles & Huberman, 1994).

METHOD

A total of 88 semi-structured interviews (over 100 hours of recorded data) and seven observations of teamwork with employees working in project teamwork from a range of functions and levels in four companies located in the US and Sweden were collected over a 15 month period. The bulk of the data was collected at a large pharmaceutical company located in the Northeast of the US. A total of 32 interviews and three cross-functional team observations were conducted to explore the initial processes of TBKW. These individuals worked on various team projects in different functions and I interviewed close to entire teams to a few ones with only a few informants. The purpose was to gain an initial understanding about the phenomenon of interest. The primary contacts in the pharmaceutical company were two senior managers in the Human Resources (HR) function that helped to arrange face-to-face meetings with senior managers in different functional areas (HR, Finance, IT, Sales, Marketing, Development, and Engineering). The goals of these meetings were to explain the project and generate interest and support for carrying out the data collection. A series of emails was sent out to explain and

encourage these senior managers' respective reports and client groups working on team projects to participate in interviews on a voluntary basis.

To further test the initial findings, I collected data (56 interviews) from five project teams in various stages from companies operating in Sweden (a large insurance company and a small engineering company) and in the US (a large consumer health product company). The sizes of the project teams ranged between 5 to 18 members and were in the middle and late stages of their projects. The entire fieldwork was carried out during a 15 month period and concluded at the stage of "theoretical saturation" (Glaser & Strauss, 1967: 65) where:

> no additional data are being found whereby the (researcher) can develop properties of the category. As he sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated ... [W]hen one category is saturated, nothing remains but to go on to new groups for data on other categories, and attempt to saturate these categories also.

Interviews. The interviews followed a conversational style (Weiss, 1994), which focuses on establishing a "partnership" where the interviewer's goal is to obtain as much rich information as possible by avoiding interruptions or changing the conversation, as long as the interviewee provides relevant information. The length of the interviews ranged from 40 to 75 minutes and each was conducted in the participant's office or a nearby conference room and was recorded using MS™ Onenote software. During the interviews, participants were asked to describe their work in their team projects. The questions were designed to allow the participant to describe the work to avoid asking leading questions. However, in case participants had a hard time explaining how they worked with knowledge, more probing questions were asked targeting knowledge

activities (see interview protocol). The answers allowed me to listen for examples of team-based knowledge work.

Analytic Strategy

There are no clear rules or guidelines for conducting grounded theory building. In general however, it follows an iterative cycle of inductive and deductive reasoning and pattern recognition. The approach followed here draws on Pettigrew's (1997:344) suggestion for a possible cycle of deduction and induction:

> The core question of the study → related themes and questions → preliminary data collection → early pattern of recognition → early writing → disconfirmation and verification → elaborated themes and questions → further data collection → additional pattern recognition across more case examples → comparative analysis → a more refined study vocabulary and research questions.

While these steps are described in a linear fashion, they may run parallel or circular.

Important to note is that researchers using a qualitative approach do not test hypotheses in the same way that quantitative researchers do. In contrast, a set of propositions are developed and refined as the research progresses and gains more clarity. Qualitative research focuses on building testable propositions rather than on hypotheses testing. Yin (2003) referred to this method as "iterative nature of explanation building", where the theoretical propositions are developed based on the data.

In order to improve the robustness of the findings, four quality tests commonly used in research were adopted: construct validity, internal validity, external validity and reliability.

Validity. Construct validity suggests "establishing correct operational measures for the concepts being studied" (Yin, 2003: 34). Several steps were taken to improve the data

accuracy. Confidentiality to participants was assured along with a signed confidentiality agreement with each organization that participated. To improve the construct validity, I relied on multiple informants for each event described, observations, and archival data to adopt a triangulation strategy (Mathison, 1988). Internal validity is a form of causal explanation, that is, to determine whether x causes y. This is particularly challenging in qualitative research give the reliance on inferences of events that many times cannot be directly observed. In order to address this issue I used pattern-matching techniques where the validity of the knowledge processes under study coincided which further strengthened the internal validity (Trochim, 1989). External validity concerns the problem of whether the study's findings are generalizable beyond the cases under investigation; a method by which the researcher is "striving to generalize a particular set of results to some broader theory" (Yin, 2003: 37). Scholars relying on a single case have been criticized for the poor generalizablity of their findings. However, I used data from different teams in pharmaceutical, insurance, engineering, and consumer health industries which strengthens the analytical generalization to establish external validity.

Reliability. In qualitative research, reliability means that the procedures used to conduct research are consistent with the aim of minimizing any potential bias or error. In order to establish reliability, I adopted a semi-structured interview protocol used across all interviews. Moreover, each interview was recorded on a laptop using Microsoft Onenote ™ software to reduce the feeling of being recorded. Recording interviews assured accuracy, avoided any potential loss of content, and allowed me to focus on the interview questions and responses rather than on the task of taking detailed notes (Weiss, 1994). Another benefit of the Microsoft Onenote™ software was that it allowed notes and coding to be taken simultaneously as the interview was conducted in the software

program. This feature eliminated the tedious task of transcribing the entire interview for coding purposes, as each highlighted section and quotes from the interview could easily be identified and accessed after the interview.

Data Coding. A threefold coding procedure including *open coding, axial coding* and *selective coding* was used to develop a grounded theory of TBKW (Miles & Huberman, 1994; scholars have used similar iterative coding procedures to identify underlying theoretical dimensions in knowledge work (e.g. Anand, Gardner & Morris, 2007). Open Coding is an initial process of identifying concepts and their properties in the data. Two informants from four of the five project teams agreed to assist in the two following coding steps and instructed regarding the intent and procedure. Using informants as part of the coding process and analysis has been adopted in various fields. The next step involves axial coding, sorting and refining the initial categories discovered in the data. The final step, selective coding, involves integrating and refining categories into a theory (Straus & Corbin, 1998). Interviews and field notes were analyzed by MS Onenote ™ to structure, organize and analyze the data. The software allowed me to highlight relevant and interesting quotes that I later could return to by simply clicking on relevant quotes.

RESULTS

Table 1 offers a comprehensive analysis of the coding procedure of each process that was involved in TBKW. During the open coding analysis, special attention was paid to continuously challenging and attempting to disconfirm the findings which are critical aspects of conducting rigorous qualitative research to assure unbiased and valid results (Miles & Huberman, 1994). The next step, axial coding, focused on conditions that would provide evidence to a category and the context in which it is embedded (Kendall,

1999). Selective coding indicates the emergence of the final conceptualizations of TBKW, where emergence is the process by which codes and categories of the theory fit the data rather than imposing the data on predetermined codes and categories (Kendall, 1999).

Insert Table 1
About Here

After an exhaustive iterative process of reducing the initial codings to a working framework, judgment calls were necessary as to what processes were really central to team-based knowledge work. For example, in Table 1, TKBW implies making decisions. However, it was evident that making a decision is an act of creating knowledge and was categorized as such. Coordination was also an occurring process and has been heavily studied in the general team literature (Stewart, 2006). Informants referred to coordination in the context of dividing tasks and aligning activities; it was categorized as a form of knowledge sharing since no knowledge was really created. That is, coordination is a form of exchanging understanding of what activities are necessary and how they are linked. Similarly, cooperation, a broad term that could include both sharing and creating knowledge, seemed to fit both knowledge processes. However, respondents referred to this process in an action-oriented manner suggesting that creating knowledge was the underlying process so it was categorized as such. These types of judgment calls allowed me to produce a more parsimonious framework, specific enough to provide a useful lens to study TBKW and broad enough to be generalizable across different types of teams.

The initial analysis suggested that knowledge sharing can be both a process of giving and seeking as well as a means to explain. Moreover, the examples in Table 1 suggested

that knowledge creation involved a range of activities that are both abstract and concrete and can range from exploitative issues such as further developing existing ideas to novel explorative ones. Finally, team learning focused on challenges that could range in magnitude, from minor errors and mistakes to more significant errors triggering reflections and questions about the boundaries and purpose of the project.

After identifying three key knowledge processes, my next task was to delve deeper into the data and explore these processes in the context of the knowledge work literature. I did so by combining the extant literature and highlighting data from the actual interviews. My intention is to allow the reader to develop their own conclusions which will further strengthen the validity of the results.

Knowledge Processes

Knowledge Sharing. Perhaps the most fundamental process in knowledge work is knowledge sharing, which became clear early on in the field work and is supported by a growing literature (e.g. Connelly & Kelloway, 2003; von Krogh et al., 2000; Szulanksi, 1996; Argote, Gruenfeld & Naquin, 2001; Ford & Chan, 2003; Darroch, 2003; Davenport & Prusak, 2000; Jackson & Erhardt, 2004). However, in line with most research on knowledge work, no agreed upon definition exists. Drawing on data from my fieldwork and the general communication literature, I view sharing of knowledge as a two-way social process whereby members are engaged in a process of creating understanding. In a sense, the individuals engaged in the process are simultaneously the sender and receiver of the knowledge. Both parties want to be confident that they understand each other by sending and interpreting verbal and non-verbal cues. In other words, without adequately understanding the knowledge being shared, the person listening is unable to interpret and

exchange additional knowledge – the act of knowledge sharing would simply be reduced to noise or exchange of data with no meaning. Aligned with the general transactional models in the communication literature, knowledge sharing (KS) is defined here as *a social process of exchanging and understanding knowledge.* A clinical trial manager in the oncology division illustrated this process in an interview during my fieldwork:

> We are constantly in and out of each other's cubes always talking, brainstorming, running things by each other, we literally shout across the hallway 'hey, are you busy, let me ask you this, hey what is going on can I run this by you'. We are always checking and re-checking because someone will always think of something that you did not think of and then you are going to have a better solution than when you started out.

The quote illustrates both the channel of knowledge exchange and the need for understanding in knowledge work. It also illustrates the importance of exchanging understanding to allow for additional knowledge creation. That is, knowledge sharing is a prerequisite for enabling more proximal factors such as knowledge creation (Kozlowski & Bell, 2003).

In a practical sense, the interviews suggested that knowledge sharing, which occurred through both FTF and virtual means, involved the movement of knowledge between team members but also the understanding of the knowledge being exchanged . Moreover, knowledge sharing appeared to be the glue that held the team together and allowed team members to create and learn – without sharing, there was no mechanism through which the team could generate new ideas or reflect on past errors or mistakes. Moreover, knowledge sharing allowed members to coordinate and keep each other updated on each

member's progress and contributions as was evident in the fieldwork. As Mark[1] working in a clinical trial team in a large pharmaceutical company reflected:

> Everything we do here involves sharing of things. I can't do my work if people don't share their ideas and questions with me. Likewise, the work I do requires me to reach out to my team to bounce ideas – it's really the main thing we do.

Knowledge sharing appeared to take on many different forms and could be transmitted via different means as pointed out by Nonaka and Takuchi (1995). For example John, working on a new insurance policy project in a large insurance company, explained that sharing of knowledge was a central aspect of their work and occurred via different means:

> I work mostly with Steve and John since their work is a bit related to what I do. When we talk, it's mostly via email or phone since a few of us work off site. We also have regular team teleconferences where we really only update each other about what we are doing.

Mary, a manager working in the Oncology function on a drug development project further elaborated on the nature of how knowledge can be shared:

> We share knowledge in different ways. Sometimes, I shout to my colleague sitting across the hallway. Other times, we meet face-to-face on an hourly basis by stopping by one of my team member's office. But the key is that it's on-going, it's the basis for moving the project forward.

The role of feedback as a mechanism to assure full understanding was also evident across interviews. Understanding was often referred to as a 'checking' or simply reporting back, as Anthony, a team member working in a product development project explained:

[1] Any names are pseudonyms to protect participants' identity

> Sometimes we divide up tasks to be carried out in sub-teams that can last for a few days to several months. The sub-team may have an assignment to solve a particular problem and then report back to the rest of the team in more formal meetings.

It became clear that depending on the tacitness of knowledge, team members many times made conscious decisions as to what means they would use to share the knowledge. This finding supports Daft and Lengel's (1984) media richness theory, which suggests that individuals make rational decisions to choose a specific communication medium contingent upon specific tasks or objectives and the degree of richness that this may include (Trevino, Daft, & Lengel, 1987). For quick and more explicit knowledge exchanges email was the preferred means of sharing knowledge. As the knowledge became more complex (i.e. tacit) members opted to interact through physical means; as Christine, a team member working on designing and marketing a new insurance policy reflected:

> It's very intensive communication on a daily basis with the group. I talk to Lisa and Johan a lot both via email, weekly meetings and a lot of formal interactions. Everybody is easy to get in contact with. You don't have to wait three days to get a response on an email. But I can't really use email for bollning [a creative process] or complex issues [involving tacit knowledge]. I guess, if I had short pucks [questions] I could use email but when I know it will just lead to follow-up questions I always pick up the phone or walk over if I can – it's just easier.

Based on my fieldwork, knowledge sharing emerged as a central mechanism in team-based knowledge work. It is in the context of the team, a mechanism for mobilizing knowledge, which allowed members to share their understanding. Yet, it is important to note that a strict conceptualization of knowledge sharing *per se* does not result in any new knowledge. For example, a team engaged in heavy knowledge exchange may not be highly effective unless the exchange results in action or implementation, i.e. knowledge

creation (Nonaka & Takeuchi, 1995). One informant from a clinical trial team provided a good example as to how both knowledge sharing and knowledge creation are linked:

> Our team members constantly ask each other for help to solve a problem or find a solution or some different way to approach a problem. This happens both in formal meetings but to a large deal just by picking up the phone or stopping someone in the hallway. It's necessary because this on-going communication keeps us updated on what everyone is doing.

Knowledge Creation. The second knowledge process salient in the fieldwork and analysis is knowledge creation, which denotes the action of conducting actual work. However, research on knowledge creation is based on a wide fragmented set of disciplines and perspectives including behavioral (Gilson & Schalley, 2004), clinical (Sass & Schuldberg, 2001; Runco & Charles, 1997), cognitive (Pollert, Feldhusen, Van Mondfrans, & Treffinger, 1969), educational (Runco, 1994), social (Albert, 1983), and organizational (Service, 2003), and has predominantly been viewed as an outcome related to products and services (e.g. Oldham & Cummings, 1996). Moreover, most scholars have conceptualized creativity as a homogeneous concept.

Notwithstanding, Unsworth (2001) pointed out that creativity can be conceptualized as a multi-dimensional construct and differentiated between responsive, expected, contributory, and proactive. What sets them apart is the notion of specified and discovered problems. That is, specified problems are given to the individual whereas discovered problems are experienced and identified by the individual. Responsive creativity focuses on finding a solution to a specific problem; expected creativity focuses on the process of creating a solution to a discovered problem; contributory creativity involves volunteered solution to a specific problem; and proactive creativity entails volunteering a solution to a discovered problem.

Knowledge creation as a multidimensional construct also parallels March's (1991) seminal work on exploitation and exploration. He defined exploration as a process involving risk taking, experimentation, and flexibility. March suggested that exploration is critical when the goal is to discover truly novel solutions or ideas. In contrast, exploitation is related to incremental refinements and modifications of existing products, methods or processes. My fieldwork indicated that explorative and exploitative knowledge creation could be part of the same project and as such were complimentary processes, which has also been discussed elsewhere (Gupta, Smith & Shalley, 2006). One example of a purely explorative project was explained by Erin, a marketing manager working in a cross-functional team developing a stand-alone medical image device:

> We lack general knowledge about how to develop this device. We don't focus on medical devices in consumer. We just don't do this very often. We don't have the level of expertise, the understanding of regulations and safety. We are learning them, but it's not a planned execution…To modify a process or to refine a process where something that is very similar to all the participants is much easier than creating something brand new from scratch. There is no business model that exists for it, there is no process map that you could follow, we don't do devices, it would be as foreign to us as to manufacture a computer. How many chips do we need to buy or have in inventory at any given time, where to get the plastic made, who is the best manufacturer for the keyboard, where to you want to put the mouse. These are the kind of questions you need to know. If you don't ask the right person, it will take much longer. We will get there eventually but it will be a much longer process.

Others conducted work that involved minor changes of existing products (exploitative knowledge creation); as Lisa, a project manager in an engineering company reflected:

> What we are doing here is a relatively simple product and we also have an old product to build from. It's relatively uncommon that we engage in ground-breaking innovation. Most of the time we continue development of existing products.

Interesting to point out is that exploitation can turn into a more explorative process that becomes more complex as the understanding progresses, as Steven, an informant from one clinical team explained:

> My manager came in the door, and told me, 'we want to change the trial that you are running. Originally, the purpose with the trial was to write a paper and publish it in a medical journal, a very standardized process [i.e. exploitative]. Now my manager told me that we want to send it to the FDA and have our label changed and this drug approved. These are two very different problems in terms of complexity, going to the FDA and getting a drug approved is a lot more complex than writing the article. So my manager wanted five top ideas from the top of my mind how we could do this [i.e. explorative process]. I started with a few ideas and then stopped myself and said, this is just too complicated for me to sit here and scope this out, and I knew this just based on my past experience. It wasn't really a team collaboration thing. I said, we need a team of people from each of the function areas to look at the problem from all directions to make sure we have addressed each of the issues. I can't think of the problems for the statistician or the problems for the data manager. I know enough to bring these people together but I don't know their specific expertise.

The example illustrates how a knowledge creation process can shift from an exploitative focus to a more explorative one that requires brainstorming and development of new ideas. It also illustrates the need for a collaborative social team process to integrate all relevant knowledge to make the project a successful one.

Through my fieldwork, it became apparent that knowledge creation included a range of activities such as creating and modifying processes, routines, ideas, solutions, to making decisions and making assessments and analyses that could be exploratory or exploitative in nature. Heidi, a human resource (HR) manager involved in an expansion sales force team in a large pharmaceutical company explained:

> There is usually a very tight project plan that you participate in creating, it's not given to you. The first meeting is: what is the goal? We have a goal of hiring 300 people in three month [sic]. What are some of the things that

> need to happen for this to take off in three months. So everyone contributes based on their role to establish what needs to be done.

The point here is that knowledge work is largely a process of creating structure and making ill-structured problems well-structured (Simon, 1973) by building alignment across the team about what the project is really about and what steps are necessary to reach the objective assigned to the team.

Knowledge creation can also include more specific actions related to more concrete tasks such as creating presentations, documents or surveys as Thomas, a Finance manager working in a cross-functional team on a climate study at a large Pharmaceutical company explained:

> We needed to create a survey for our data collection. We all met as a group and reviewed the initial draft that was put together with an external consultant. The consultants had conducted some initial interviews and put together some initial survey questions. We as a team met and brainstormed some additional questions on themes we wanted to get at. The consultant incorporated our ideas and we met again as a team and reviewed it again and shared it with management later on to make sure we captured the main issues and identified the next steps in the process.

The fieldwork also suggested that team-based knowledge work could shift between coordination, a purely knowledge sharing activity to workshop mode, more of a knowledge creation activity; as Leif, a manager in product development function in a large insurance company explained :

> Workshop mode is a form of FTF meeting where ideas are discussed back and forth. We don't really have an agenda and all individuals are expected to pitch in with their perspectives to work. Team meetings is [sic] a different form of meeting where there is a clear agenda with a team leader in charge of the meeting. It involves more reporting, updating and coordination. It's of course possible that team meetings can turn into workshop modes regarding some questions but not the other way around. It's similar to a brainstorming format.

The difference in interaction between workshop mode and coordination was further observed in several team meetings. It was evident that coordination was not an act of creating new ideas or solving a problem but rather a purely administrative knowledge sharing activity (and categorized as such, as mentioned earlier). Once workshop mode occurred, the dynamics changed dramatically to a highly interactive almost chaotic interaction that combined knowledge sharing and knowledge creation where members freely offered their perspectives and listened intensively to each others' suggestions and ideas. It became apparent that team-based knowledge work was an iterative process of creating types of knowledge as the project progressed. One idea can lead to the next in an explorative or exploitative fashion. In light of my fieldwork, knowledge creation is defined here as: *iterative processes of producing, developing and implementing work related ideas.*

Team Learning. Team learning is a much wider and more complex research domain that includes a variety of approaches from different disciplines. While the interest in the notion of learning in the organizational context is on the rise, scholars have argued that the growth of research in this area in recent years is characterizes by ambiguity, lack of consensus and growing confusion (Pawlowsky, 2003). Part of the confusion can be attributed to how team learning has been conceptualized which includes local and distal learning (Wong, 2004), incremental and radical learning (Edmondson, 2002), and cycle of experimentation (Gibson & Vermeulen, 2003). Zeller-Bruhn and Gibbs, (2006) drawing on Argote's (1999) work, conceptualized team learning as acquiring, combining, creating and sharing knowledge. Given the many variations of the conceptualizations of team learning, Edmondson, Dillon and Roloff, (2007) argued that team learning is a

useful concept that cannot be thought of as a single specific organizational phenomenon but should focus on more specific learning processes.

Through my interviews and observations, it became apparent that knowledge work involved making working assumptions and decisions that later proved incorrect resulting in errors and mistakes forcing the team to adjust or question decisions made. Drawing on Tuckman's (1965) stages of team development (i.e. forming, storming, norming and performing), Kozlowski et al., (1999), argued that team learning is the team's ability to adjust and adapt as team-members' tasks, boundaries, and responsibilities are in constant flux. This learning is also referred to as team adaptability (Lepine, 2003). That is, as teams follow their work routines (Gersick & Hackman, 1990), there is an occasional need to change them as unanticipated challenges occur.

This uncertainty forced teams to make assumptions and decisions that many times were incorrect, triggering errors. Argyris and Schon (1996) argued that this mismatch between expected and actual outcomes triggers a need to change. In line with scholars pointing out that team learning is a form of change as a result of the recognition of dynamic situations and errors or obstacles (Argyris & Schon, 1996; Kozlowski et al., 1999), team learning is defined here as: *a social process of conscious effort by a team to change based on unexpected problems or mistakes*. One informant from the fieldwork illustrates the importance of change:

> My direct report came to me and said, I have this problem with the clinical trial, there is a patient and the nurse said, I can't get anybody to call me back; I can't get an answer from the patient. I said, 'there is no such thing as not getting an answer'. The physician has a question about the medical test, there is no not calling back, you just have to figure out how to get the answer. Either the coordinator does not want to be embarrassed by going to the physician saying 'I can't get an answer, can you call and use your clout?' There is always a way, so while you are running with the baton around the track, no matter what, there is a solution and we believe that.

> You throw up an obstacle, we go around it like water running down the stream. For example, the sales figures here were not good, we went in a different direction. Or, we had a new research area that we started two new trials. Guess what, they tanked! So we went over to another area. We are constantly changing, changing our direction, and that's clear from the top of the organization to our unit. And this is why we explain to our people that it's not what you have to do but why you have to do it that's important. So we have to believe in what we are doing and that we are all pulling in the right direction towards the same goal.

The quote illustrates the constant nature of change and adjustment. Barriers are part of knowledge work that cannot be anticipated many times but part of TBKW is about adapting and developing new solutions that will continue to drive the project forward.

Fieldwork also indicated that obstacles or errors could differ in terms of magnitude requiring different responses. This is what Argyris and Schon (1996) referred to as single- and double-loop learning. Single-loop learning is a lower-level learning which means adjustments in the form of on-going small incremental learning that produces successive replacements or refinements of responses. In contrast, double-loop learning is profound adjustment that includes a change of the theory-in-use. In other words, single-loop learning attempts to address a problem by incremental adjustments that lie within the governing variables. Double-loop learning involves solving a problem that requires a team to consider solutions beyond given assumptions, norms and systems. Both learning processes appeared to hobble teams engaged in TBKW. For example, a team may be developing a new vacuum machine. One team faced a problem when they realize that the new suction technology was not working as planned and had to be modified. The change was based on a design error but was not vital for the overall project since it could be addressed with minor modifications (i.e. a single-loop learning episode). George, a clinical trial member illustrated the role of single-looping:

> We constantly have to change our plan; it's part of the work. We run into problems constantly. We just have to figure out how to work around it. There is always a way to find a solution, and we believe that.

Single-loop learning -- incremental changes to minor problems -- facilitated by on-going discussions occurred frequently in all types of teams. A project manager from the medical device project explained this iterative process of trial and error:

> We don't control everyone in the team that works for us or in the organization. In terms of managing our processes, how to avoid obstacles, how to manage our stakeholders better, how to negotiate with the leaders of the organization to achieve the objective we want - a lot of that goes on in our team in terms of what is working. We try new things all the time, we can try this, or try something else that didn't work too well last time, we have to decide if we should change our approach. These discussions happen all the time.

At times, larger, more significant challenges (i.e. double-loop learning) occurred that made members question fundamental assumptions of the overall purpose of the project. A major double-loop learning episode occurred in one of the insurance projects. It started with an incorrect assumption of shared understanding that later ended up questioning the entire purpose of the project. As Olof, a business line manager reflected:

> I thought we all had an understanding about the price [of the insurance]. But I guess it wasn't that clear. When Eva was going to launch the marketing campaign the problem became evident. The idea of marketing the insurance for 99 [Swedish crowns] came from the steering committee. I was very firm about that this is not a "discount" insurance. That's when John and the other member's bosses had to have several meetings to solve this disagreement. From a sales perspective, I understand that they want to sell as much insurance as possible. We from the product side, we don't want to create an image of being a discount company selling a cheap product. We don't compete on that level and we don't want to sell this product on a large scale. This is a specialized product for a small market for families that have teenagers that needs an insurance [sic].

Another example of double-loop processing occurred in a cross-functional sales force team explained by Michelle, the HR support person for the sales division and part of the project:

> We needed to establish criteria for incentives for sales representatives. We thought that you need to be top 3rd of your team for 2 out of 3 years to get a higher commission, which really didn't make sense when we applied it. So when you come across decisions made in the past they are sometimes not fully thought through, and we need to ask ourselves if this is what we intended when we set the criteria in place? How do we revisit it? How do we get this changed? The criteria made sense at the time, but we ultimately needed to change it.

The quote illustrates the processes of reflecting back on the overall purpose of the project. It is viewed as a double-loop learning episode given the questioning of the pre-established norms and understanding that had to be changed.

A team member of an organizational development project reflected on the constant change in the project forcing the team to continually assure alignment of the purpose of the goal:

> There is a lot of discussion of a project plan, but quite frankly, the moment you act things change, personnel changes take place, regional changes take place, and you are mid-stream and suddenly, two of the sponsors moved to different roles, so where are we now? It happened several times. So we needed to find new sponsors of the project which was a challenge to keep this project moving forward. This meant that we many times had to revisit our initial goal to make sure we were all in agreement.

One team in an insurance company faced a double-loop learning episode that evolved in workshop mode involving collaboration with a support team (IT). The challenge occurred due to communication problems. The team spent an entire workshop (a three hour meeting) working to determine why this happened and it was concluded that emails and phone calls were not sufficient to keep the support team informed and up to date

about the most current changes and decisions. As a result, the team engaged in knowledge creation mode to develop new processes to avoid these double-loop learning episodes from reoccurring.

The link between knowledge sharing, knowledge creation and team learning. Team learning is linked to and requires both knowledge sharing and knowledge creation at both forms of learning (i.e. single- and double-loop learning). One project involved developing and marketing a new insurance for younger customers. As the insurance content materialized the team ran into the problem of marketing the new insurance as one member reflected:

> One problem was to market the insurance that we didn't really think would be a problem. We needed to understand how to make the connection between young people and their parents. I think I should have been more pro-active to understand that this would become a problem… I think my problem was to figure out how to appeal to young costumers. How do you sell an insurance to them? They are young and don't really think of insurance issues. I was thinking about creating a package with a smoke detector to send the customer to generate some buzz but how sexy is that?

The quote illustrates the challenge with not anticipating an important aspect of the project that later turns out to be a problem in a single-loop sense. This challenge created a series of debates as to how to best appeal to the new customer base, illustrating the dynamics between knowledge sharing, knowledge creation and making a single-loop adjustment to market the product.

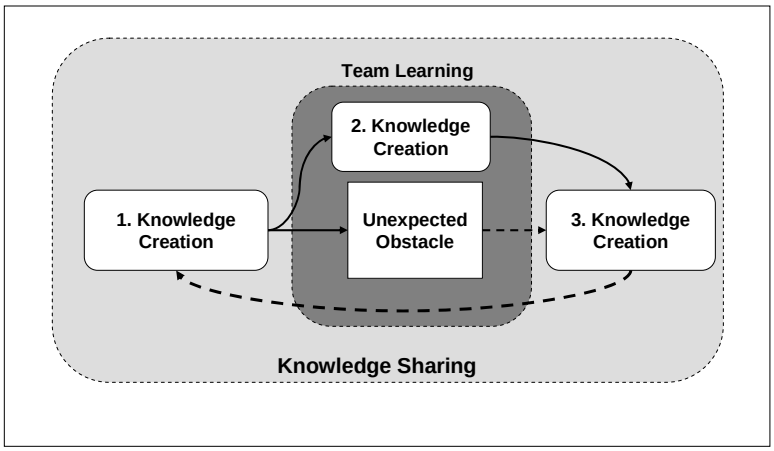
Another example of the linkage between the three knowledge processes was explained by one informant working on a project for developing a stand-alone medical device:

> The team acknowledged the problems of poor alignment. As a result, we sat down as a team and put things on a piece of paper on May 15th. I just had to go back and refer to something we had decided and say – on May 15th we decided xy z. At the end of that day, the key to this is to make sure that we review this periodically and that as things change, we need to constantly update as we have many conversations. Within a day, that plan we developed was obsolete, we were making agreements and changing dates, re-prioritizing, and not updating the document. A month later, we sat down again and revised the document. The main problem is the countless informal conversations on the side between two people that may have lunch together. They make a decision without informing the rest of the team

The quote illustrates the on-doing discussions in each meeting to formalize the plan of action (i.e. knowledge sharing). Knowledge creation is the activity in documenting and updating the plan. Single-loop learning was a result of the disconnect between previous decisions and failure to update the working document.

Figure 1 depicts all three processes and illustrates how they are linked. Knowledge sharing is viewed as the central process of any social knowledge work to occur and is indicated in the largest gray area. Without any social interaction there can be no actual teamwork. However, exchange of knowledge does not create any new knowledge *per se*. The team has to actually produce something, that is, knowledge creation. Knowledge sharing facilitates this iterative knowledge production process. Team learning is an event resulting from an obstacle or error faced or made by the team, whereby the team has to adjust and develop new options to overcome the barrier and can vary in magnitude. The process of TBKW is an on-going cycle as indicated by the feedback loop in the figure as the team moves closer to the end goal.

Figure 1
Conceptual Model of Team-Based Knowledge Work



One informant when reflecting on the nature of team-based knowledge work illustrated the link between knowledge sharing, knowledge creation and team learning:

> When projects are very "specialist-based" there is less need for tight interdependent work. Specialist projects are typically very clear and linear, which allows you to specify what you need and what competence is necessary. When you are dealing with more abstract or poorly defined projects you have a different interdependence. Although it's possible for one person to drive the entire project, multiple perspectives are used to consider problems and created in the end a superior outcome. So it's not the specific knowledge alone that links people in the project but rather the need of different perspective and input that makes it more interdependent. This project is poorly defined which means that you need constant interaction to drive the project and handle un-anticipated problems on an on-going basis. Addressing problems is just the nature of the work. That's what's makes it so challenging but interesting at the same time.

The quote highlights the social aspect of knowledge work that requires constant exchange of knowledge. Each person has a piece of the puzzle but needs input in the form of other members' perspectives to develop ideas and solutions. It also illustrates the constant

challenge to address and overcome problems in order to drive the project closer to the end.

Existing Quantitative measures of knowledge processes

The results suggest that team-based knowledge work is a multi-dimensional construct involving knowledge sharing, knowledge creation and team learning. Current research is built on measures that do not capture the entire construct of team-based knowledge work. Perhaps more importantly, these measures have been developed without sufficiently acknowledging the distinctions between these behaviors as team constructs. This has resulted in development and use of inadequate measures reviewed in Table 2. It should be noted that this analysis is not intended to discredit existing measures, but rather, to highlight and build on these initial valuable contributions in their respective areas and point out the need to think critically about the distinction between various knowledge processes and refine existing measure to further explore TBKW.

Insert Table 2
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Turning first to measurement approaches for knowledge sharing, Buckman, (1998) and Ford and Chan (2003), adopted a case study approach using interviews at the organizational level. While interviews are useful for exploration and theory development it typically limits the generalizability of the findings beyond the sample population. In an attempt to address actual knowledge sharing, Bock and Kim (2002) measured both explicit and tacit knowledge shared among individuals in the form of: number of reports, documents, who they knew, know-how and expertise. This first attempt was followed by

a later study that explored intension to share knowledge (Bock et al., 2005). Connelley and Kelloway (2003) adopted a perceptual measure of perceived knowledge sharing. However, limited studies have addressed knowledge sharing at a team unit of analysis with a few exceptions. For example Zarraga and Bonache, (2003) used a perceptual measure of the degree of knowledge sharing within the team although they viewed it as an outcome variable. A more serious limitation was that the items they used appeared to reflect not only knowledge sharing but also learning and knowledge creation.

Within organizational behavior and managerial research, knowledge creation in teams has typically been measured as an outcome rather than as a process (e.g. Zarraga & Bonache, 2003). For example, Leenders, van Engelen and Kratzer (2003) used an actual measure by asking members of new product development teams to assess their teams in terms of the number of new ideas, methods and inventions created as a result of working together. However, with a few exceptions, only limited numbers of studies have focused on knowledge creation as a team process. Gilson and Shelly, (2004) for example, adapted Jabri's (1991) measure of individual creativity and modified it to the team level. They asked team leaders (not the team members themselves) to rate the extent to which their teams were engaged in creative processes using a six item scale. Moreover, De Drue (2002) adapted Anderson and West 's(1999) measure of team innovativeness. While the items used appear to capture the construct, they focused on product services. Research on learning at the organizational unit of analysis is characterized by qualitative approaches with limited hypothesis testing (e.g. Senge, 1990; Argyris, 1993). Research on team learning has commonly adopted more quantitative methods using perceptual measures (e.g. Edmonson, 1999). Edmondson (1999) developed a measure on team learning in a manufacturing company using both qualitative and quantitative approaches and while this

measure is one of the most frequently adopted (e.g. Da Silva et al., 1999; Van Der Vegt, 2005), it appears to show similar problems to those seen with Zarraga and Bonache's (2003) measure. It does not differentiate between different sub-dimensions of team-based knowledge work.

DISCUSSION

Based on 15 months of fieldwork this paper contributes to the extant literature on knowledge work by offering a working parsimonious framework for understanding central knowledge processes involved in TBKW. While scholars have discussed each knowledge process identified in the fieldwork, they are commonly confounded with one another and used interchangeably. In order to provide clarity and help advance our understanding as to how knowledge is mobilized in the workplace, the framework offered here will serve as a conceptual starting point for scholars and practitioners. Team-based knowledge work is developed here as a multifaceted concept (Loehlin, 1987). The underpinning for this conceptualization is the evidence reviewed above that teams conducting knowledge work are engaged in knowledge processes including communication (i.e. knowledge sharing), development and on-going improvements of their day-to-day work (knowledge creation) and change and adaptability (i.e. episodic team learning) to address errors and mistakes.

Towards a Team-Based Knowledge Work Theory

The theory put forth here suggests that each process alone is necessary but insufficient to explain the complex phenomenon of team-based knowledge work; knowledge sharing, knowledge creation and team-learning are all part of knowledge work and need to be considered in concert. Knowledge sharing is the means that makes both

knowledge creation and team learning possible; it is a fundamental element for any new knowledge to emerge. Moreover, understanding what knowledge is being shared is critical as it may dictate the quality and accuracy of any subsequent knowledge being created. Knowledge sharing is the glue that holds the team together and allows team members to create and learn – without sharing there is no mechanism through which the team can generate new ideas or work around unexpected problems. In practical terms, knowledge sharing is also the process that allows members to coordinate and keep each other updated on each member's progress and contributions. However, while exchanging understanding is the prerequisite, it does not create new knowledge in a strict sense. This is what separates knowledge creation from knowledge sharing.

Knowledge creation is fundamentally an action process that involves development of new ideas, processes, solutions, products, improvements and so forth to carry out the task assigned to the team. It is a process that involves applying the know-how of the team over an iterative process. This process can vary in magnitude from making small incremental refinements (i.e. exploitative) to more groundbreaking ideas, thinking out side the box ideas (exploratory). The point here is that it is a set of social processes that rely on the effectiveness and ability to share what members know and apply it towards relevant tasks for the overall project. However, since knowledge work is commonly conducted on the edge of what is known, members have to make assumptions and decisions based on limited knowledge under time pressure. As such, errors and mistakes are bound to occur and need to be addressed, which is part of the very conceptualization of team-based knowledge work.

Team learning is the act of change and adjustment of the team's project plan or direction as it moves closer to the end objective. As teams face tight deadlines,

assumptions and decisions have to be made in a satisficing manner (Simon, 1959) which at times proves incorrect. This forces the team to re-consider and modify previous decisions. Some errors create single-loop learning episodes while others have a more significant impact in the form of double-loop learning episodes. This learning may trigger the need to create a new solution to the challenge at hand. For example, the team may learn that the current way work is structured is not efficient enough to reach a project milestone on time and modify their practice. Yet, improving a practice may not necessarily result in the change of a team's established project path. Important to note is that learning is not just merely change (Edmondson et al., 2007), but rather the acknowledgement that the current approach for addressing a problem is inadequate or wrong and is the act of changing this project path.

While teamwork can undoubtedly involve other work processes such as monitoring, assisting, coaching, etc. what distinguishes work processes from knowledge processes is the knowledge involved in the actual work. Knowledge creation is any actual activity contributing to the project's progress. It is of course theoretically possible to create knowledge without sharing it, but in a team context, this is virtually impossible – knowledge creation is fundamentally a social process requiring some degree of knowledge being exchanged. Although knowledge creation and team learning are closely related, there is an important distinction to be made. While knowledge creation is a process that creates new ideas, solutions, and incremental improvements to carry out the work, team learning is the act of change and adjustment of the team's project plan or direction. However, this learning may trigger the need to create a new solution to the challenge at hand. Thus, the working theory offered here assumes that knowledge is what separates TBKW from non-TBKW. It is fundamentally a social process that requires

input and collaboration from multiple individuals. Moreover, it is a multifaceted construct based on three distinct but highly related processes needed to mobilize knowledge.

From a practical standpoint, the findings suggest that firms engaged in TBKW need to foster climates for these processes to prosper. While this was not explored in the present study, the extant literature indicates that the process of knowledge sharing can be enhanced by linking it to specific human resource practices such as compensation incentives (Zarraga & Bonache, 2003). And successful knowledge creation has been attributed to the means in which members interact (Okhuysen, & Eisenhardt, 2002). Edmondson (1999) pointed out that feeling safe to speak up and voice individual opinions is essential for learning to occur. However, additional research is needed that considers all three knowledge processes in conjunction and that specifically explores when and how these knowledge processes can be fostered for effective TBKW.

The analysis of existing measures on knowledge work (table 2) revealed several limitations that scholars need to acknowledge. First, scholars need to be careful about using existing measures as the measures seem to confuse the three knowledge processes outline here. Second, many of the measures have been developed at the individual level and are not suitable for team-level research. These methodological concerns suggest that scale development is needed to further advance our understanding regarding various factors that may impact TBKW and subsequently its effectiveness.

An important limitation to acknowledge here is one that most qualitative researchers face – the challenge of collecting data from a large enough sample size to generalize the findings. However, the purpose of qualitative research is theory building rather than hypothesis testing. Moreover, the focus of this paper has been the *process* of team-based

knowledge work. As such, conformity to the current "variables paradigm" where social reality is parsed into fixed entities and where causality is attributed to these variables was not appropriate (Abbott, 1992). Instead, I used an inductive approach supported by the extant literature to further shed light on the inner workings of team-based knowledge work. However, in addition to scale development, quantitative research is needed to test the proposed framework across teams working in different contexts and companies that may further support or disprove the framework of TBKW developed here. Researchers should explore under what conditions this framework holds and what factors may impact the nature of the work. One promising area to explore is how the nature of the project impacts the three knowledge processes identified here.

This paper adds to the extant literature on knowledge work by offering a working framework for understanding what and how different knowledge processes are involved in TBKW. Yet, we have only begun to scratch the surface on this emerging area of research. It is my hope that the theory and conceptualization of TBKW will offer a helpful lens for researchers to further explore knowledge work in teams. While this framework may need adjustments as we continue to propel forward in this research stream, it is essential to foster a shared approach and to develop a common body of knowledge of concepts and notions in this research area to avoid further confusion in the field.

Table 1
Coding Process:

Open Coding and Conceptualization	Axial Coding	Selective Coding
"Questioning" Part of reaching an understanding by raising questions about a decision or logic.	Explaining	**Knowledge Sharing**
"Clarification" Similar to questioning but more focused on reaching shared understanding.	Explaining	
"Help me understand" explaining what it is you are saying and could be assisted with a power point slide, process map.	Explaining	
"Walk me through" A similar concept to "help me understand" where somebody has worked on a task and is about to present the work. It is a more informal way of presenting but the main idea is to share knowledge.	Explaining	
"Negotiation" A process where members' opinions and perspectives are voiced.	Discussions	
"Sit down together" A process that can be both be a knowledge sharing process as well as a knowledge creation activity depending on the purpose.	Discussions	
"Reaching consensus" Different perspectives are shared and discussed resulting in a shared understanding.	Discussions	
"Sit down and have a discussion" Exchange of knowledge (could be a knowledge creation process if a decision is reached).	Discussions	
"Having all the appropriate opinions" Assuring a problem has been addressed form all possible angles.	Discussions	
"Feedback" Part of the traditional communication processes where understanding is assured by feedback from the receiver.	Assuring understanding	
"Understand each other" Fundamental for knowledge sharing.	Assuring understanding	

Open Coding and Conceptualization	Axial Coding	Selective Coding
"Make sure that this makes sense"	Assuring understanding	
Elimination of potential noise and distraction to assure members fully grasp the idea.		
"Need a second pair of eyes"	Assuring understanding	
Making the sure knowledge is comprehensible.		
"Let's look at it"		
Could involve considering a problem and making sure there is shared agreement about the nature of the problem.	Assuring understanding	
"Assessment"	Assuring understanding	
Can involve taking stock on current progress or evaluation of a decision made.		
"Sharing my ideas"	Knowledge giving	
A process of sharing ideas and understanding of these ideas.		
"Bring something up"	Knowledge giving	
Expressing ideas in an informal or formal meeting.		
"Communicate with the team"	Knowledge giving and seeking	**Knowledge Sharing**
Simple form denoting the act of sharing knowledge.		
"Circulate the minutes from the meeting"	Knowledge giving and seeking	
Sharing of codified knowledge via emails.		
"Need to know"	Knowledge giving and seeking	
Knowledge is passed from one member to the other(s).		
"Putting on the table"	Knowledge giving and seeking	
Offering ideas (could be also be a knowledge creation process if ideas are further developed).		
"Quick Pucks"	Knowledge seeking and giving	
Short questions sent via emails that normally require a quick answer.		
"Make sure that people are talking"	Alignment of actions and tasks	
Illustrates the fact that team members are communicating.		

Open Coding and Conceptualization	Axial Coding	Selective Coding
"Touch base with all members"	Alignment of actions and tasks	
Symbolizing clear communication for updates and coordination.		
"Coordination"	Alignment of actions and tasks	
Activity to align tasks to avoid overlap and misunderstanding.		
"Building alignment"	Alignment of actions and tasks	
Similar to coordinating by making sure team members fully understands what everyone is doing.		
"Spend some time digesting the idea"	Knowledge processing	
Members reflect and process knowledge for understanding.		
"Discussing differences of opinions"	Knowledge processing	
Opportunity for voicing members' perspectives and to build shared understanding.		
"Getting people tuned in"	Knowledge processing	
Focus on the receiver that members listen and fully understand what is being shared.		
"Challenging the idea"	Idea development	
A process of questioning and offering alternative solutions.		
"Let's build on that"	Idea development	
Is a notion used to express the need to further develop an idea offered by a team member; could be either an explorative or exploitative process.		
"Flesh out the ideas"	Idea development	**Knowledge Creation**
Continue to develop an idea. Could be both explorative and exploitative.		
"Incorporate ideas"	Idea development	
A process of considering multiple perspectives.		
"Developing"	Idea development	
Symbolizing the process of knowledge creation and can be incremental or novel.		

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Open Coding and Conceptualization	Axial Coding	Selective Coding
"Creating" Similar to developing and is the act of producing either abstract or concrete knowledge.	Idea development	
"Find a way to solve it" An active process of considering ideas to address a question or problem.	Idea development	
"Add some additional thinking" Consider other options to improve an idea. Commonly an exploitative process.	Idea development	
"Push us a little bit further" Combine perspectives to elevate a current solution. Commonly an exploitative process.	Idea development	
"Brainstorming" A pure form of knowledge creation. Usually occurs in explorative contexts.	Idea development	
"Rallying" An exchange of questions and answers in an interactive format. The intent is to improve on an initial idea, create something new or verify that a solution is suitable. This process can be either exploitative or explorative in nature.	Idea development	
"Carve out" A notion used to express what the team needs to do in order to reach the team's objective. Effective project teams are those that quickly establish the scope of the project with the mission and strategy together. This is generally an explorative process.	Knowledge assessment	
"Map out the project" This mapping normally takes place in the beginning of the project where the framework (project's boundaries) are identified and set. Raising a lot of questions for the team to think about and offer solutions. Similar to "carve out" and is mostly an explorative process.	Knowledge assessment	
"Lay out the process" Documenting a process.	Knowledge assessment	
"Distributing the work" A knowledge creating activity where each person is assigned tasks and responsibilities.	Knowledge assessment	
"Framing the problem" A process of creating boundaries around a problem.	Knowledge assessment	

Open Coding and Conceptualization	Axial Coding	Selective Coding
"Setting expectations"	Knowledge assessment	
A creative process that requires shared understanding. **"Figure out what needs to be done"**	Knowledge assessment	
Could include developing an action plan. **"Establishing criteria"**	Knowledge assessment	
A rule of thumb to base decisions on. **"Record the minutes from the meeting"**	Knowledge Codification	**Knowledge Creation**
A form of knowledge creation where knowledge is codified in documents or emails. **"Problem solving"**	Knowledge application	
A process that involves multiple perspectives to address a problem. Could be either an explorative or exploitative process. **"Making joint decision"**	Knowledge application	
A social process of considering individuals' ideas and action on knowledge. **"Build the team charter"**	Knowledge application	
Example of knowledge production. **"Run with the idea"** Considering a solution and executing it. **"Developing charts"**	Knowledge application Knowledge application	
Specific example of knowledge production. **"Executing"**	Knowledge application	
A practical form of knowledge creation that involves applying knowledge.		

Open Coding and Conceptualization	Axial Coding	Selective Coding
"Offer help and receiving help" Illustrating a two way process of knowledge creation by offering ideas or being assisted with a problem.	Knowledge application	
"Get this done" An act of producing by applying knowledge.	Knowledge application	
"Utilization of skills" Each person brings a set of knowledge and experiences to the table. The key is that everyone has the opportunity to express their ideas and integrate them in the project, which can be conducted in an explorative or exploitative fashion.	Knowledge application	
"Work very closely together" Indicating a social process of creating knowledge. Could be either an explorative or exploitative process.	Knowledge application	
"Moving the project forward" A broad concept that implies continued knowledge creation.	Knowledge application	
"Planning" A cognitive knowledge creation process to consider necessary steps and milestones for the project.	Knowledge application	
"Cooperation" A broad term that may involve either sharing and/or creating knowledge. However, most informants used it in the context of action driven activities of creating knowledge.	Knowledge application	
"Lessons learned" A notion to describe errors and mistakes made by the team. Generally a single-loop learning event.	Recognition of past mistakes	**Team Learning**
"Questioning ourselves" **A** process of reflection and re-thinking the purpose and goal of the project. This is a form of double-loop learning	Reflection	
"Scope Creep" **A** tendency to diverge from the initial objective of the process; a form of double-loop learning.	Re-aligning the project scope	

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Open Coding and Conceptualization	Axial Coding	Selective Coding
"Re-think" Addressing a previous decision that turned out to be wrong or not optimal.	Adjustments of current ideas or solutions	
"Back to the drawing board" The acknowledgement that current processes/decisions are not working.	Adjustments of current ideas or solutions	
"Setbacks" An unforeseen obstacle that prevents the team from moving forward; a form of single-loop learning.	Unforeseen problems	
"Running into problems" Failure to anticipate a problem affecting the current project path.	Unforeseen problems	
"Barriers" A problem that prevents the team from moving forward, which is typically unanticipated	Unforeseen problems	
"Hitting a dead end" Acknowledgement that the current approach is not working and a need to adjust the strategy and related processes.	Errors and mistakes	
"Getting stumped" Reaching an obstacle or lack of solutions for a current challenge requiring adjustment in the current approach.	Lack of anticipated alternatives	

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Table 2
Existing Measures on Knowledge Work:
Overlaps of Measuring Learning, Sharing and Creating Knowledge

Type of Instrument: Knowledge Sharing	**Sub-constructs of knowledge work**					
Actual Knowledge Sharing (Bock and Kim, 2002) How frequently do you share the following knowledge with your organizational members? Please tick in the most appropriate box for each question:	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
1. Reports, Official Documents.		√			Four large public organizations from 75 departments Individual n = 467. Chief employee = 49.9% Employee = 21.7% Manager 7.2%	Alpha = 0.82
2. Manuals, Methodologies, Models		√				
3. Know-Where, Know-Whom		√				
4. Experience, Know-How		√				
5. Expertise from Education & Training		√				
	Sub-constructs of knowledge work					
Perceived Organizational knowledge sharing (Connelly and Kelloway, 2003)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Define KS as: a set of behaviors that involve the exchange of information or assistance to others.						
1. People in this organization are willing to share knowledge/ideas with others.		√			Inidividual n = 126. MBA and undergraduate students 26 individuals were not students	Alpha = 0.74
2. People in this organization keep their best ideas to themselves (R).		√				
3. People in this organization share their ideas openly.		√				
4. People with expert knowledge are willing to help others in this organization.		√				
5. This organization is good at using the knowledge/ideas of employees.			√			
	Sub-constructs of knowledge work					
Intension to share knowledge (Bock et a., 2005)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Intention to Share Explicit Knowledge:					Pilot test: n = 61	Alpha = 0.93

1. I will share my work reports and official documents with members of my organization more frequently in the future.		√		√	respondence from 13 organizations in 7 industries in Korea. Main study: n = 154 participants. Chief ee = 44.8%, Managers = 35.7%, Employees 11.7%, Directors = 7.1	
2. I will always provide my manuals, methodologies and models for members of my organization		√		√		
Intention to Share Implicit Knowledge:						
1. I intend to share my experience or know-how from work with other organizational members more frequently in the future.		√		√		
2. I will always provide my know-where or know-whom at the request of other organizational members.		√		√		
3. I will try to share my expertise from my education or training with other organizational members in a more effective way.		√		√		
Team knowledge sharing (Zarraga & Bonache, 2003)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Degree of transfer of knowledge in the work team					N = 363 individuals (not teams) participated from several large Spanish firms	Alpha = 0.70
1. In my work team, I have learned new things from my colleagues that only they knew.	√					
2. In my work team, I have shared knowledge and experiences from my past (in this company or in others) that only I knew.		√				
3. In my work team, it is normal that, as a result of ideas contributed by a member, we have related ideas that we had never considered before, and which we go on to develop.			√			
Type of Instrument: Learning	**Sub-constructs of knowledge work**					
Team Learning (Edmondson, 1992)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Define team learning: on-going process of reflection and action, characterized by asking questions, seeking feedback, experimenting, reflection on results, and discussing errors or					N = 53 teams in a Office Manufacturing	Alpha = 0.78

unexpected outcomes of actions.					company (34 functional teams, 9 self managed teams, 5 cross-functional P&D teams, 3 cross-functional team	
1. We regularly take time to figure out ways to improve our team's work processes.			√			
2. This team tends to handle differences of opinion privately or off-line, rather than addressing them directly as a group.				√		
3. Team members go out and get all the information they possibly can from others – such as customers, or other parts of the organization.	√			√		
4. This team frequently seeks new information that leads us to make important changes.			√	√		
5. In this team, someone always makes sure that we stop to reflect on the team's work process.	√	√	√			
6. People in this team often speak up to test assumptions about issues under discussion.		√				
7. We invite people from outside the team to present information or have discussions with us.	√	√				
Team Learning (Da Silva et al., 1999)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
1. We take the time as a group to consider how we may work better together.			√		Pilot test using undergraduates (n = 97) Employees of a large metropolitan gov agency (n= 343). Do not measure teams.	Alpha = 0.94
2. In my work group, everyone is encouraged to speak freely, regardless of position or title.		√				
3. Information is freely shared within this work group.		√				
4. This work group contributes to my growth.	√					
5. My work group often discusses opportunities for improvements.		√	√			
6. People in my work group learn from one another.	√					
7. When I get stuck, I can count on my work group to help provide ideas.		√	√			

8. In my work group, important issues are discussed, even when they are sensitive to some people.		√				
9. People decide as a group what to do about problems within the unit.		√	√			
10. In my work, we celebrate our successes.				√		
11. People in my work group are open to expressing their feelings about work issues.		√		√		
12. The contribution of every group member is valued.				√		
Work unit Learning: Foley & Armstrong (unpublished)						
1. My section/work unit has a sound process for prioritizing my learning and developmental needs.				√	N = 866 employees no more information is provided	Alpha = 0.77
2. I am satisfied with how my learning and development needs are currently being identified.				√		
3. The skills of existing employees are developed in line with business objectives.	√			?		
4. I participate in staff training, learning and development decisions.	√			√		
5. I clearly understand what skills and knowledge I need to be able to do my job well.				√		
Type of Instrument: Knowledge Creation	**Sub-constructs of knowledge work**					
Team Creative Environment (Gilson, Mathieu, Shalley & Ruddy, In Press)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
1. In my team, we welcome new ideas		√	√		Customer service technicians in a Canadian large office equipment company. N teams = 90 (individuals = 379)	Alpha = 0.79
2. In my team, people are encouraged to try new things, even thought they might not work			√			
3. We are willing to try creative solutions to solve difficult problems.	√		√			
Team knowledge creation (Zarraga & Bonache, 2003)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Degree of creation of knowledge in the work team					N = 363 individuals (not teams) participated from several large	Alpha = 0.60

					Spanish firms	
1. My work team has come up with idea/s for improvement that the company has subsequently put into operation.			√			
2. In my work team, we have generated many improvements on the traditional way of doing things.			√			
	Sub-constructs of knowledge work					
Team Creativity Items (Gilson & Shalley, 2004)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
1. Your team is methodical and consistent in the way it tackles problems. (reverse coded)			√	√	Large mulit-national UK company. 11 work teams, Individual n = 137. 100% males,	Alpha = 0.80
2. Your team is open to the implementation of new ideas and ways of doing things.			√			
3. Your team links ideas that originate from multiple sources.		√	√			
4. Your team is persistent in solving a problem even when it takes them into areas they know nothing about.			√			
5. Your team searches for novel approaches not required at the time.			√			
6. Your team pays strict regard to the sequences and steps needed to complete a job. (reverse coded)			√			
Team Innovativeness (De Drue, 2002) Adapted from Anderson and West, 1999					N = 215 individuals in 32 teams	Alpha = 0.80
1. Team members often implement new ideas to improve the quality of our products services			√			
2. This team gives little consideration to new and alternative methods and procedures for doing their work (reverse coded)			√			
3. Team members often produce new services, methods, or procedures			√			
4. This is an innovative team			√			
	Sub-constructs of knowledge work					
Team Creativity (Leenders, van Engelen & Kratzer, 2003) Team members rated the team in terms of:	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
1. Generating new ideas			√		New Product Development teams in 11 electronic	Inter-rater = .076
2. Generating new methods			√			
3. Generating new approaches			√			

4. Generating new inventions			√		companies. Teams n = 44 (individuals n = 243)	
5. Generating new applications			√			
Other Related Measures						
	Learning	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Hoegl and Gemuenden, (2001) Teamwork Quality					N = 145 teams from 4 German software development laboratories	Alpha = 0.91
Communication						
1. There was frequent communication with the team		√				
2. The team members communicated often in spontaneous meetings, phone conversation etc.		√		√		
3. The team members communicated mostly directly and personally with each other		√		√		
4. There were mediators through whom much communication was conducted (r)		√		√		
5. Project-relevant information was shared openly by all team members		√				
6. Important information was kept away from other team members in certain situations (r)		√				
7. In our team there were conflicts regarding the openness of the information flow (r)		√		√		
8. The team members were happy with the timeliness in which they received information from other team members		√		√		
9. The team members were happy with the usefulness of the information received from other team members		√		√		
Coordination						
1. The work done un subtasks within the project was closely harmonized			√	√		
2. There were clear and fully comprehended goals for subtasks with our team				√		
3. The goals for subtasks were accepted by all team members				√		
4. There were conflicting interests in our team regarding subtasks/subgoals (r)				√		
Balance of Member contribution						

1. The team recognized the specific potentials (strengths and weaknesses) of individual team members				√		
2. The team members were contributing to the achievement of the team's goals in accordance with their specific potentials			√	√		
3. Imbalance of member contribution caused conflicts in our team (r)				√		
Mutual support						
1. The team members helped and supported each other as best they could			√	√		
2. Discussions and controversies were conducted constructively		√		√		
3. Suggestions and contributions of team members were respected		√	√	√		
4. Suggestions and contributions of team members were discussed and further developed		√	√			
5. Our team was able to reach consensus regarding important issues				√		
Effort						
1. Every team member fully pushed the project				√		
2. Every team member made the project their highest priority				√		
3. Our team put much effort into the project			√	√		
4. There were conflicts regarding the effort that team members put into the project (r)				√		
Cohesion						
1. It was important to the members of our team to be part of this project				√		
2. The team did not see anything special in this project (r)				√		
3. The team members were strongly attached to this project				√		
4. The project was important to our team				√		
5. All members were fully integrated in our team				√		
6. There were many personal conflicts in our team (r)				√		
7. There were personal attractions between the members of our team				√		
8. Our team were sticking together				√		
9. The members of our team felt proud to be part of the team				√		
10. Every team member felt responsible for maintaining and				√		

protecting the team						
	Learning	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Creative Team environment (Gilson et al., 2005)					N team = 90 N individuals = 379 Sample were technicians repairing office machines	Alpha = 0.79
1. Team members welcomed change	√					
2. Team members encouraged each other to try new things, even though they may not work			√	√		
3. Team members were willing to try creative solutions to solve difficult problems			√			
Innovative Climate (Bock at al., 2005)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
1. My department encourages suggesting ideas for new opportunities.			√	√	Pilot test: n = 61 respondence from 13 organizations in 7 industries in Korea. Main study: n = 154 participants. Chief ee = 44.8%, Managers = 35.7%, Employees 11.7%, Directors = 7.1	Alpha = 0.87
2. My department puts much value on taking risks even if that turns out to be a failure.			√	√		
3. My department encourages finding new methods to perform a task			√	√		
Collaborative Climate: Sveiby & Simons (2002)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Sub-dimensions:					Individual n = 8277. 63.3% in private sector and 43.3% in public sector. 76.7% were employees, 16% were managers and 7.2% were consultants	
Organizational culture						Alpha = 0.89

1. The people I report to keep me informed.		√				
2. Sharing of knowledge is encouraged by the Department in action and not only in words.		√		√		
3. We are continuously encouraged to bring new knowledge into the Department.		√		√		
4. We are encouraged to say what we think even if it means disagreeing with people we report to.		√		√		
5. Open communication is characteristics of the Department as a whole.		√		√		
Immediate Supervisor:						Alpha = 0.85
6. Encourages me to come up with innovative solutions to work-related problems.			√	√		
7. Organizes regular meetings to share information.		√		√		
8. Keeps me informed.		√		√		
9. Encourages open communication in my working group.		√		√		
10. Encourages – by action and not only words – sharing of knowledge		√		√		
Employee Attitudes:						Alpha = 0.88
11. I learn a lot from other staff in this Department	√					
12. In the Department, information sharing has increased my knowledge.	√	√	√			
13. Most of my expertise has developed as a result of working together with colleagues in this Department.	√	√	√			
14. Sharing information translates to deeper knowledge in this Department.		√	√			
15. Combining the knowledge amongst staff has resulted in many new ideas and solutions for the department.		√	√			
Work Group Support:						Alpha = 0.81
16. There is much I could learn from my colleagues.				√		
17. There are people here who prefer to work on their own (R).				√		
18. We often share work experiences informally in our unit/section.		√				
19. We help each other to learn the skills we need.	√					
20. We keep all team members up to date with current events (e.g. news) and work trends.		√				

Team climate Inventory (Anderson & West, 1998)	**Learning**	**Knowledge Sharing**	**Knowledge Creation**	**Other Construct**	**Sample**	**Reliability**
Participation:					No pilot sample. Main study: 35 hospitals in UK. EFA: n = 155 managers. CFA: n = 971 team members	Alpha = 0.89
1. We share information generally in the team rather than keeping it to ourselves.		√		√		
2. We have a 'we are in it together' attitude.				√		
3. We all influence each other.		√	√	√		
4. People keep each other informed about work-related issues in the team.		√				
5. People feel understood and accepted by each other.		√		√		
6. Everyone's view is listened to, even if it is in a minority.		√		√		
7. There are real attempts to share information throughout the team.		√		√		
8. There is a lot of give and take.		√		√		
Interaction Frequency:						Alpha = 0.84
9. We keep in touch with each other as a team.		√		√		
10. We keep in regular contact with each other.		√		√		
11. Members of the team meet frequently to talk both formally and informally.		√		√		
12. We interact frequently.		√		√		
Support for Innovation:						Alpha = 0.92
13. This team is always moving towards the development of new answers.			√			
14. Assistance in developing new ideas is readily available.			√	√		
15. This team is open and responsive to change.	√		√			
16. People in this team are always searching for fresh, new ways of looking at problems.			√			
17. In this team we take the time needed to develop new ideas.			√			
18. People in the team co-operate in order to help develop and apply new ideas.		√	√			
19. Members of the team provide and share resources to help in the application of new ideas.			√	√		
20. Team members provide practical support for new ideas and their applications.		√	√			
Task Reflexivity (Tjosvold, Tang & West, 2004)	**Learning**	**Knowledge**	**Knowledge**	**Other**	**Sample**	**Reliability**

		Sharing	**Creation**	**Construct**		
1. The team often reviews its objective				√	300 teams (1 manager and 2 ee)	Alpha = .88
2. We regularly discuss whether the team is working effectively together		√	√			
3. The methods used by the team to get the job done are often discussed		√	√			
4. In this team we modify our objectives in the light of changing circumstances	√					
5. How well we communicate information is often discussed		√	√			
6. This team often reviews its approach to getting the job done		√	√			
7. Team members identify strengths in their work and areas that need improvement			√	√		
8. Team members are committed to ongoing improvement			√	√		
9. Team members are open to improved ways of working			√	√		

Interview Protocol

Exploring the Construct of Team-Based Knowledge Work

Overall Purpose:
The purpose of this interview is to understand how people collaborate in teams that operate in environments that require a great deal of information sharing and creativity. Your answers are strictly anonymous and will not be shared with anyone accept the research team from Rutgers University. The information will be destroyed after the completion of this project. The length of this interview is expected to last approximately 40 minutes. Your participation is voluntary and you can decide to end this interview at any point. However, your participation in this project is very valuable and will be used to identify key behaviors in the process of team collaboration in order to improve team performance.

1. General Information

Q1.	Tell me a little about yourself. Probe on: specialty, time in current position, experience with this company/industry.
Q2.	To what extent is your function involved in team or project work?
Q3.	What type of teams/projects do you have in your function? Probe on: Size, lifespan, team composition.
Q4.	Does teamwork typically involve other functions?

2. Background Information on Team

Teams may vary in size from 2-3 to 30-40 members. The notion of teams is used here to include people that you work closely with on a regular basis, which can also include projects or workgroups. Please think of a project that you are currently involved in as basis for the remaining questions (is there a name of the name of the team?).

Q5.	Could you please tell me about something you are currently working on that involves teamwork? Probe on: purpose with the team, team composition (i.e. size, functional, experience).

3. General Questions on Team Collaboration

Q6.	As I mentioned earlier, this study is about understanding how people work together in teams. If you reflect on your current team that we have been talking about, could you please describe how you
Q7	typically work together?
Q8	How do you normally communicate with each other (e.g. email, phone, formal/informal meetings)?
Q8a	How are the meetings typically structured?
Q9.	How often to you meet face-to-face?
Q10.	Related to how you work, what are some things the team is doing well?
	What are some things that could be improved?

4. Knowledge Sharing

	If the participant has not discussed knowledge sharing, probe on:
Q11.	If you think about information sharing, can you think of an example when you shared information with your colleagues? Probe on the 'how' information was shared rather than on
Q12.	enabling tech.
Q13.	To what extent do you rely on sharing of information as a basis for your work?
Q13a.	Do you share information in different ways depending on what information you are sharing?
	If so, can you think of a concrete example?

5. Knowledge Creating

	If the participant has not discussed knowledge creation, probe on:
Q14.	One reason for using teams is to improve creativity and innovation. Can you think of a concrete example of how your team identified and/or developed an idea (e.g. product related)?
Q15.	Leaving aside the final outcome of the project, what type of work processes (or standard
Q16.	operating procedures) does your team use?

	To what extent are these processes modified/improved as the teamwork moves forward?

6. Team learning

	If the participant has not discussed team learning, probe on:
Q17.	To what extent is addressing errors and mistakes part of your daily work in the project?
Q17a.	Can you think of a concrete example of when you as an individual or as a team faced a problem and how you managed to solve it
Q18.	How would members of your team react if you made a mistake?

7. Other comments

At this point, I don't have any further questions. Are there other key aspects of work that you and your team members are involved in that I might have overlooked?

CHAPTER 3

STRUCTURAL PROBLEMS AND DISTRIBUTED KNOWLEDGE: IDEAL TYPES OF TEAM-BASED KNOWLEDGE WORK

ABSTRACT

Teams are a central mechanism to mobilize knowledge. However, limited research has offered careful explorations of the complex dynamic processes and nuances in different types of team-based knowledge. Adopting a case-based approach, the following paper develops a grounded framework for understanding four ideal types of team-based knowledge work (TBKW). A total of 56 interviews from four project teams operating in different companies in Sweden and in the US was collected along with supplemental survey data. Findings suggest that the structure of the problem and knowledge distribution are central to explain dynamics and effectiveness in four different types of TBKW (Standardized, Modular, Emerging and Collaborative). Theoretical and practical implications are addressed and future research directions discussed.

Key words: team-based knowledge work, ill-structured problems, knowledge sharing, knowledge creation, team learning

There is little doubt that knowledge has become a central factor for companies to compete on in a rapidly growing knowledge economy (Kogut & Zander, 1992; Grant, 1996; Machlup, 1962; Porat, 1977; Rubin & Huber, 1986; Powell & Snellman, 2004). The emphasis on knowledge in the workplace, rooted in increased specialization, has created greater interdependence in terms of teamwork (Heckscher & Adler, 2006; Mohrman, Cohen & Mohrman, 1995). This is moving organizations to adopt teamwork structures to better leverage and integrate individuals' expertise necessary to solve complex problems (McDonough, Kahn & Barczak, 2001; Blasi & Kruse, 2006).

Teams are a key mechanism to leverage and mobilize knowledge (Kanter, 1987; Senge, 1990; Grant, 1996; Edmondson, 1999; Gilson & Shalley, 2004; Lawrence & Lorsch, 1969; Rubinstein, 2000). Research on various forms and types of teams is abundant including work, parallel, management, decision-making and project teams, advice and involvement teams, production and service teams, project and development teams, action teams and negotiation teams (Stewart, 2006; Kozlowski & Bell, 2003; Cohen & Bailey, 1997; Sundstrom, De Meuse & Futrell, 1990; Jackson, May & Whitney, 1995; Bell & Kozlowski, 2002; Gully, 2000; Sundstrom, De Meuse & Futrell, 1990). The focus here is on temporary knowledge teams, or what practitioners often refer to as project teams. These types of teams provide a clear start and end point during a finite length of time they are involved with a specific problem. More importantly, knowledge-intensive firms are increasingly leveraging project teams to structure work where members from different functions are brought together

to leverage and mobilize their individual knowledge to address a shared problem (Heckscher & Adler, 2007). Cohen and Bailey (1997: 242) summarized project teams nicely as:

> "…time-limited…for the most part non-repetitive in nature and involve considerable application of knowledge judgment, and expertise. The work that a project team performs may represent either an incremental improvement over an existing concept or a radically different new idea."

Project teamwork is a critical mechanism through which knowledge can be created and leveraged. Grant (1996, 1996b) referred to teams as "knowledge integrators" which may occur through interactions between team members. Along similar lines, Mohrman, Cohen & Mohrman (1995) pointed out the importance of teams as knowledge creating mechanisms where task interdependencies and perspectives can be worked out and constant learning is required since much of the work is on the cutting edge. The notion of team-based knowledge work (TBKW) is adopted here to describe this collaborative process involving knowledge, a form of project teamwork.

Yet limited research has explored knowledge work in project teams which makes them a pressing issue to better understand, especially for companies that compete based on knowledge (Zack, 1999). Specifically, there are two pressing issues that remain unexplored in research on project teamwork (and in the general team literature). First, few scholars have taken a closer look at nuances and the dynamics within different types of TBKW. Project work tends to be broadly defined without much consideration for variations in how work can be organized in various projects. Second, while scholars have made important contributions to identify key

"knowledge processes" including knowledge sharing (Bock & Kim, 2002; Zarraga & Bonache, 2003; Argote, McEvily & Reagans, 2003), knowledge creation (Gilson & Shalley, 2004; Leenders, van Engelen, & Kratzer, 2003; Argote et al., 2003), and team learning (Edmondson, 1999; Kozlowski, Gully, Nason & Smith, 1996; Gully & Phillips, 2005), the research on processes involved in TBKW remain fragmented and poorly integrated.

The study addresses these two limitations by, first, demarcating a grounded framework for understanding four types of TBKW. Second, w*hen* organizations can and, perhaps more importantly, *should* use project teams in the context of knowledge work is not well understood. This paper aims to advance our understanding regarding effectiveness of team-based knowledge work. Without clear answers to these questions, knowledge work is likely to remain challenging for any entity that competes based on knowledge. By adopting a case-based approach (Yin, 2003), I provide a grounded theoretical framework to understand dynamics in four different project teams.

In framing the introduction, I have employed key theoretical concepts that emerged from the study (Suddaby, 2006). A traditional grounded interpretative approach would entail complex data presentation before the reader is presented with the theoretical dimensions and learn what the major contribution would be. In other words, the theory would typically appear after the data presentation. However, for the sake of clarity a conceptual overview is presented first. This overview is organized by first reviewing the extant literature on team processes and its limitations, followed by a discussion of TBKW and related concepts impacting the types of TBKW. Next, a

theoretical framework is delineated along with propositions for different types of team-based knowledge work that outline when and how this work is conducted.

THEORETICAL BACKGROUND

Knowledge Processes

There is general agreement among scholars and practitioners that knowledge has the potential to create and maintain a competitive edge and has been well articulated by Grant (1996, 1996a) in his seminal work on the knowledge-based view of the firm. However, research that is linked with knowledge work as a team process is characterized by confusion of concepts and remains poorly integrated. The framework of team-based knowledge work developed here draws from organizational theory, knowledge management (KM), and general management literature focusing on key processes of knowledge work (e.g. Alvesson, 2004; Drucker, 1999) as applied to the team context.

Scholars have made important contributions to identify key "knowledge processes" including knowledge sharing (Bock & Kim, 2002; Zarraga & Bonache, 2003; Argote, McEvily & Reagans, 2003), knowledge creation (Gilson & Shalley, 2004; Leenders, van Engelen, & Kratzer, 2003; Argote et al., 2003), and team learning (Edmondson, 1999; Kozlowski, Gully, Nason & Smith, 1996; Gully & Phillips, 2005). These constitute the foundation for the processes of team-based knowledge work presented in this paper.

What ties these three processes together and makes it important to address in concert is *knowledge*, defined as *understanding gained by intellectual and or practical experience* (Alvesson, 2004; Davenport & Prusak, 2000). *Knowledge*

sharing involves the exchange of understanding that can occur through various means such as formal or informal face-to-face interactions or virtual interactions such as email and phone (Berlo, 1960; Kirkman, & Mathieu, 2005). *Knowledge creation* is the process that expands on individuals' understanding and creates new knowledge such as ideas, solutions etc (Gilson & Shalley, 2004) and can be exploitative or explorative in nature (March, 1991). March suggested that exploration is critical when the goal is to discover truly novel solutions or ideas. In contrast, exploitation is related to incremental refinements and modification of existing products, methods or processes. Both processes can be viewed as practices of combining knowledge where one mobilizes existing knowledge in new ways and the other mobilizes knowledge through well-understood standardized processes (Taylor & Greve, 2006). These processes must start and end with knowledge. Without having previous knowledge the team is unlikely to create new knowledge. It should be pointed out that explorative and exploitative knowledge creation is viewed here as complementary processes; one does not exclude the other as both are deemed necessary for successful knowledge work that may be pursued during different cycles in the project (see Gupta, Smith & Shalley, 2006 for an extensive review).

Knowledge is also critical for *team learning* to occur, viewed here as a form of team adjustment in response to errors and obstacles (Kozlowski et al., 1996). In a classic Pavlovian sense, knowledge is the stimulus that triggers team learning. Without knowledge, such as the current status of a project, feedback from senior management, or challenges raised by team members, the team is unlikely to adjust or modify the current project plan to overcome barriers or errors. Team learning can

vary in magnitude and is what Argyris and Schon (1996) implied with the notions of single- and double-loop learning. Single-loop learning is defined as lower-level learning, or adjustments in the form of on-going small incremental changes that produce successive replacements or refinements of responses. In contrast, double-loop learning is profound adjustment that includes a change of the theory-in-use. In other words, single-loop learning attempts to address a problem by incremental adjustments that lie within the governing variables. Double-loop learning involves solving a problem that requires a team to consider solutions beyond given assumptions, norms and systems.

Ideal Types of Team-Based Knowledge Work

Team-Based knowledge work is a form of project teamwork given its purpose of merging and leveraging different knowledge. Yet, few scholars have actually explored how different *types* of TBKW are actually carried out. An exception is Perlow, Gittell and Katz's (2004) exploratory case-based study where they identified three different types of TBKW (managerial centered, expertise centered and team centered) and interdependence in each type. While they did not specifically use the notion of TBKW, it overlaps with the current conceptualization used in this paper. Their findings suggested that the nature of work (helping team members) were both affected by and affected the reward structure in the team. I extend this line of research by building a contingency theory, which posits that the structure of the organization (in this case the team) is most effective when it fits the nature of the task and the requirements of the environment it operates in (e.g. Lawrence & Lorsch, 1967; Galbraith, 1977). Incorporating this theory into knowledge work, I attempt to shed

light on four different ideal types of TBKW that are contingent upon the *structure of the problem* assigned to the team and *the knowledge necessary to address/complete the problem*. These are two central issues in TBKW since the structure of the problem is the very purpose as to why a project team is formed; and there is a range of knowledge necessary to address this problem. While project teamwork is rarely completely successful (Donnellon, 1993) and many projects are terminated prematurely, the notion of 'ideal types' is used in a theoretical sense to provide a useful lens through which we can understand the complex reality of TBKW.

Structural Problems. An important aspect of TBKW is the problem or task that commonly constitute the project. This task can vary in terms of clarity referred here to as the structure of the problem, which can range from ill- to well-structured. The notion of ill- and well structured problems is not new and researchers have used different approaches to describe it. For example, Ackoff (1979) used the term "mess" to describe a dynamic situation consisting of complex systems of changing problems interacting together. Schon (1987) used the notion of "swampy situations" and Rittel and Webber (1973) referred to this notion as "wicked situations" in contrast to "tame problems." Wood (1986) differentiated between component complexity, coordinative complexity, and dynamic complexity. Moreover, the whole organizational contingency stream from Burns and Stalker (1961) to Lawrence and Lorsch (1967), along with many others, is essentially based on this distinction. Tushman (1978) outlined four dimensions of project task complexity specifically relevant for R&D projects: basic research, applied research, development and technical service.

On one hand, ill-structured problems have vague descriptions of the issues faced by the team, or the information needed to solve the problems is generally not provided at the onset of the project (Chi & Glaser, 1985). The problem may possess multiple criteria for evaluation or solutions, in the absence of a universal agreement on the appropriate solution (Voss, 1988) and may require intense interaction where members express personal opinions or beliefs about the problem (Meacham & Emont, 1989). In addition, members cannot freely make individual decisions since multiple solutions may exist and need to be agreed on among the team members; a good solution for one team member may be a poor one for another member. It is important to note that knowledge work often entails making decisions and assumptions that are less then optimal and at times incorrect when faced with ill-structured problems. Thus, tight deadlines coupled with the need to move forward make errors and mistakes an inherent factor in team-based knowledge work involving ill-structured problems.

On the other hand, well-structured problems are clearly presented with the necessary information and have convergent answers and single solving processes to address the problem (Simon, 1978, 1973). Each role and responsibility is easily identified or given at the onset of the project and the team can quickly move into action without extensive deliberation. The clear and shared objective of a project makes it easy for all team members to understand how each role adds to the final outcome, which makes individual decisions possible that will add value and result in reaching the objective.

Distributed Knowledge. The role of distributed knowledge, broadly defined here as the team's combined intellectual and practical understanding, perspectives, experience and views, has been frequently studied and theorized in the general team literature (e.g. Hollenbeck et al., 1995; Keller, 2001; Harrison, Price, Gavin, & Florey, 2002; Erhardt, Werbel & Shrader, 2003; Brodbeck, Kerschreiter, Mojzisch & Schultz-Hardt, 2007) and the organizational theory literature (e.g. Heckscher & Adler, 2006). It is conceptualized here as a social process that includes combined knowledge creation to be constituted as such. Distributed knowledge has been linked with the type of task performed by the team (Brodbeck, et al., 2007; Jassawalla, & Sashittal, 1999). For example, Olson, et al., (1995) argued and provided evidence that the performance of cross-functional product development teams depends on the complexity of the project/product. As the task at hand grew more complex, interdependence increased and required more decentralized cross-functional teams, more distributed knowledge and intense interactions among team members. However, more bureaucratic structured teams, with clear roles and well-understood and pre-established routines, were more efficient on less innovative projects such as line extensions or product improvements (i.e. in a more exploitative fashion).

Research Questions

Taken together, the structure of the problem and distributed knowledge are distinct but related notions. However, we still have limited understanding as to how knowledge processes are related and impact the nature of the knowledge work. The focus here is to build grounded theory to understand different types of TBKW and the dynamics within them. This focus is rooted in a set of research questions. First, how

does the nature of the problem relate to the three knowledge processes outlined above? Second, what is the relationship with distributed knowledge?

METHOD

I adopted a qualitative case-based approach in order to explore the dynamics in different types of team-based knowledge work. A qualitative approach is more advantageous than quantitative approaches for exploring new contemporary concepts that are grounded in the workplace (Miles & Huberman, 1994). Moreover, qualitative methods are useful to explain *why, how* and *when* a complex phenomenon occurs (Yin, 2003). The bulk of the data was captured via a total of 56 interviews (over 65 hours of recorded data) along with supplemental data such as team observations, over 400 emails between team members, observations and documents, team charts, and presentations. I collected data from four project teams in various stages from companies operating in Sweden (a large insurance company and a small engineering company) and in the US (a large consumer health product company). In contrast to quantitative research that commonly adopts random sampling based on statistical deliberations (Miles & Huberman, 1994), these cases were chosen given a set of criteria suitable for the research questions addressed in the study: teams that 1) operated on a project basis with a clear beginning and an ending and 2) engaged in knowledge work involving abstract and conceptual work where judgment was central with various degrees of interdependence. In order to assess the validity of a team, the initial assessment regarding the suitability of each case was done by several discussions with the initial key contact persons. The size of the project teams ranged

from 5 to 18 members and the teams were in the middle and late stages of their projects. Ten months of fieldwork was completed at the stage of "theoretical saturation" (Glaser & Strauss, 1967: 65) where:

> no additional data are being found whereby the (researcher) can develop properties of the category. As he sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated ... when one category is saturated, nothing remains but to go on to new groups for data on other categories, and attempt to saturate these categories also.

Analytic Strategy

Researchers using a qualitative approach do not test hypotheses in the same way common quantitative researchers do. In contrast, a set of propositions are developed and refined as the research progresses and gains more clarity over an iterative cycle of deduction and induction (Pettigrew, 1997). Moreover, qualitative research is more concerned with hypothesis building than hypothesis testing. A common analytic strategy to build testable hypotheses is case-based research. Yin (2003) referred to this method as "iterative nature of explanation building", where the theoretical propositions are anchored into the cases that may support or reject the hypothesis and may result in modifications of the hypothesis.

To further strengthen the robustness of the findings, four quality tests for construct validity, internal validity, external validity and reliability were adopted.

Validity. Construct validity implies that the researcher establish suitable operational measures for the phenomenon under investigation (Yin, 2003). Several steps were taken to improve the accuracy of the data. I followed standard internal review board's (IRB) requirement to assure confidentiality for each organization that participated. Construct validity of the types of TBKW was established by relying on

multiple informants for each event described, several observations, and archival records to triangulate the data (Mathison, 1988). Internal validity concerns whether x causes y. I adopted pattern-matching techniques where the validity of the knowledge processes studied coincided which further strengthened the internal validity (Trochim, 1989). External validity is achieved if the study's findings can be generalized beyond the cases under investigation. This is a technique where the researcher is attempting to generalize a set of results to a broader theory (Yin, 2003). This is commonly a challenge for scholars using a single case to generalize their findings beyond the sample. However, I used data from several teams operating in different industries which improves our ability to generalize the findings beyond the four cases and to establish external validity.

Reliability. Reliability is achieved if the procedures adopted are consistent which would minimize any potential bias or error. To this end, I developed a semi-structured interview protocol used for all interviews. Moreover, each interview was recorded on a laptop using Microsoft Onenote ™ software. Recording interviews is a common technique in qualitative research and assures accuracy, avoids any potential loss of content, and allows the investigator to focus on the interview questions and responses rather than on note taking (Weiss, 1994). Another benefit of using the Microsoft Onenote™ software was its various features that enable me to take notes and code while conducting the interviews. This feature eliminated the need for transcribing each interview as each highlighted section and quotes of the interview could easily be identified and accessed after the interview based on a simple search function.

Interviews. The interview format followed a conversational style which aims at establishing a "partnership" in order to obtain as much rich information as possible (Weiss, 1994). This is best accomplished by avoiding interruptions or changing the conversation too much as long as the discussion is within the boundaries of the phenomenon under investigation. Hence I adopted a semi-structured interview format. The length of the interviews ranged from 40 to 75 minutes and each was conducted on site in or near the participant's office. The interviews included broad questions such as "describe the project you are working on." More specific questions were asked as the interview progressed such as: "what knowledge do you have and what knowledge is necessary to carry out the project"; "how would you describe the complexity of the project"; "to what extent are members clear about their roles and responsibilities"; and "to what extent do you encounter disagreements among team members regarding the purpose or goal of the project?"

Data Coding. I adopted a coding procedure suggested by Miles and Huberman (1994) including open coding, axial coding and selective coding to analyze the data. *Open Coding* is an initial process of identifying concepts whose properties are discovered in the data. The next step involves *axial coding*, sorting and refining the initial categories discovered in the data. The last step involves *selective coding*, whereby I integrated and refined categories into a theory (Straus & Corbin, 1998). Moreover, I used MS Onenote ™ software program to structure, organize and analyze the data. The software allowed the creation of codes and the highlighting of relevant and interesting quotes that I later could relisten to by using the search function in the

program. This saved a lot of time and sped up the analysis since each interview did not have to be transcribed verbatim.

Supplemental Survey Data. Team members were asked to complete a short web-based survey to further triangulate the findings. Questions were asked regarding the structure of the project, such as: “individual’s roles are clearly understood”, “individual’s responsibilities are clear” and “our project is well defined”. Distributed knowledge was assessed by a set of questions including: “the combined knowledge in the team is very diverse”, “team members hold very different perspectives necessary for the project”, “the team collectively has all the knowledge needed for the project”. Each knowledge process was assessed by three sets of questions. Knowledge sharing was assessed by questions including: “team members frequently voice their individual ideas”, “continued exchange of knowledge is a natural part of working together in our team”, and “team members really spend time trying to understand each others' perspectives”. Knowledge creation was assessed by questions including: “team members jointly identify alternative solutions to the problem at hand” and “Team members constantly search for new ways of solving a problem”. Team learning was assessed by questions such as: “we have had disagreements among the team members about how to define the problem or the goal we are working on” and “Our team’s goals have developed and changed as the group worked on the problem”. Each question contained a 7-point Likert scale ranging from “strongly disagree” to “strongly agree”. The response rate for each team ranged between 100 percent and 80 percent.

ANALYSIS

Scholars involved with qualitative research face a challenge in summarizing and presenting findings in a clear and straightforward manner. This analysis is subjective in nature and involves a great deal of judgment on behalf of the researcher. However, qualitative research is often criticized for not offering enough detail and rigor in its methodological approach and analysis (Suddaby, 2006). While this criticism may have some merit, I addressed this frequently cited request for good quality research by including the most relevant quotes supporting my arguments in each case summarized below. This approach was adopted to allow readers to develop their own conclusions regarding the nature and dynamics in each team that ideally would correspond with mine.

During the analysis, special attention was made to continuously challenge and attempt to disconfirm the findings which are critical aspects of conducting rigorous qualitative research to assure unbiased and valid results (Miles & Huberman, 1994). Each case with relevant quotes is illustrated below to give the reader a sense of the dynamics in the team supporting the propositions presented earlier.

Standardized TBKW: Project Wheel-Base

The project in the Swedish manufacturing company involved re-designing a suction mechanism for automobile exhaustion to enable in-door repair work. The project team used standard processes with a core team with clear roles and responsibilities that did not change from project to the next. The project was not highly complex requiring several functions but was essentially driven by the designer. Once the designer had created a first working prototype, other members became

involved in a sequential manner. The small team included the designer, a central Figure in the process, the project manager, several laboratory technicians, external vendors, the purchaser, and finally a knowledge integrator that collected all relevant technical knowledge necessary to build instruction manuals and technical components included in the manufacturing process. While there were several functions represented in this process, I categorized this project team as having low distributed knowledge. This may seem contradictory, however, since the 'knowledge production' was confined to the designer, as the support functions assisted in standardized operations there was limited social work related interactions among team members. Each supporting role was predefined and clear with no overlap of expertise and was therefore considered a well-structured project with low distributed knowledge. Each of the three knowledge processes will be further analyzed below.

Knowledge Sharing. The levels of knowledge exchanged between the members of this team were relatively low. Several days could pass without any interaction among the team members. However, emails were an important communication tool which was facilitated by computer software that allowed the designer to share ideas, as Joe[2], the product designer reflected:

> There isn't that much communication. I can work relatively alone and once I have an idea, I share it with the project manger and others to bounce ideas off them. When we do communicate, emails are used a lot to share the product since we can design it in our computers.

Knowledge sharing also occurred occasionally in informal ways but was more serendipitous in nature. For example, several informal coffee breaks and lunches were observed which allowed individuals to exchange ideas and to reflect on previous

[2] Any names used are disguised to protect participants' identities

decisions and alternatives. However, these encounters were not planned or formally structured and not viewed as the formal way of conducting work.

Knowledge Creation. The exploitative (March, 1991) nature of work (refinements of the existing product) was central to explaining the relatively low interaction between persons in the team. Knowledge creation was mainly the responsibility of the product designer, but infrequent face-to-face meetings for knowledge creation occurred. These meetings were mainly conducted in the beginning for the product designer to get input from several people, as George, the project manager explained:

> The product designer typically sits in his room and draws and develops an idea and buys components to put together a prototype. But it happens that we meet as a team. We had a few brainstorming sessions in the beginning to generate some new ideas and develop the product. We had some people coming in from the production side that mentioned the importance of standard screws, which I think was valuable.

These sessions, however, were not formalized or viewed as central processes for the work itself and tended to be dominated by the product designer.

Team Learning. Since the work was highly predictable and each person's responsibility was predefined, coupled with a standardized work process, it created limited team learning episodes. However, as the technical product was finalized, there were episodes of single-loop learning necessary to adjust the product. These adjustments were technical in nature and based on initial testing that forced the designer to interact with the project manager to work out potential solutions, As Joe described:

> The electrical outlets have been a problem. We really don't know where we can find them. The person first developing the box just took some parts on the shelf and put together. Now we can't find these outlets which is creating problems. We can't find the right size and that changes everything from design to function. We have gotten very far but when we want to move this product to the mass scale, we needed to take a step back and re-design a few things so that everything could fit in the box.

This learning episode also highlights the sequential order of producing the product where each member has a specific task that is addressed independently.

Performance. The project of re-designing the product did not face any major setbacks that altered the preset launch date for the product. The steering committee from the headquarters evaluated the project as a success. The product designer was able to not only design the new product on time but also to cut costs based on ideas from a previous project in an exploitative fashion.

In sum, in standardized TBKW, all three knowledge processes are relatively limited in use. Where the workflow is sequential in nature, there is no real use of a collaborative team, but rather a bureaucratic form of workflow prevailed with pre-established independent roles and responsibilities and little room for explorative knowledge creation.

Modular TBKW: Project Start

The second project studied in Sweden involved a company launching a new insurance policy originally developed in Norway and specially tailored for younger customers. The team consisted of seven core members from different functions including: project manager, content specialist, internet, learning/education, market analyst, IT, and marketing. The E-letter project was well structured since it had

already been developed and implemented in Norway. Accordingly, each person had a good understanding about his/her role and responsibilities at the onset of the project. In addition, even though the project was clear, it still required representation from different functions with relevant perspectives and understanding of the local market. Each individual had to engage in knowledge creative activities that were later linked to the overall project in a pooled type of interdependence. Thus, the project was characterized as well-structured with high distributed knowledge. Each of the three knowledge processes will be analyzed next.

Knowledge Sharing. The clear roles and responsibilities for each person created a highly modular workflow. Knowledge sharing was clearly kept at a minimal level where days could pass by without any communication. This lack of interaction was attributed to the fact that each person was an expert on the subject matter of their respective tasks which meant that there was no practical reason to interact. Most of the interactions involved coordination and updates as explained by Sten, the project manager:

> Well, we work relatively independently. My job is straightforward and clear so I don't really need team meetings to work out things in workshops [sic] modes. I work mostly with Steve and John since their work is a bit related to what I do. When we do talk sometimes [sic] but it's mostly via email or phone since a few of us work off site. We have also have regular team teleconferences where we really only update each other about what we are doing.

Although members were dispersed across several cities, team informants explained that the work would not have been any different if they were all located in one building. Moreover, the nature of the work did not require close interaction as explained by Jenny, another team member:

> We had an objective, we knew what we had to do but each member did not have to document what their specific task was. We don't need to know specifics of each other's tasks. Each person working in the team is an expert in his area so I don't want or need to know how he is going to accomplish the task

Knowledge Creation. Team members occasionally reached out to each other for ideas or input for problems. However, the clear lines of roles and responsibility tended to maintain the focus on individual independent knowledge work, as Sue, the learning and training manger explained:

> I work with people from other functions and when I have specific questions related to my field, I commonly get the answer – well this is your area, I have no idea what you should do. Then I have to bring the question back home and ask the other specialists that I sit with to get some ideas how to solve my problem.

The nature of the task, adjusting an already existing insurance policy, made knowledge creation exploitative in nature (March, 1991). Each person relied on their individual expertise to make minor adjustments to fit the Swedish market, as Lars, the product specialist explained:

> We are not dealing with a revolutionary product here. It's essentially repackaging an old product into a new one for a slightly different customer base. We have done this many times before and this is nothing new to any of us.

Team Learning. The well-structured nature of the project reduced the tendencies for team learning episodes to occur. However, limited interaction coupled with the cross-functional nature of the team created errors which forced the team to interact. As Olof, the product manager explained:

> I think we all had an understanding about the price [of the insurance]. But I guess it wasn't that clear. When Eva was going to launch the marketing campaign the problem became evident. The idea of marketing the insurance for 99 [Swedish crowns] came from the steering committee. I was very firm

> about that this is not a "discount" insurance. That's when Lars and the other members' bosses had to have several meetings to solve this disagreement. From a sales perspective, I understand that they want to sell as much insurance as possible. We from the product side, we don't want to create an image of being a discount company selling a cheap product. We don't compete on that level and we don't want to sell this product on a large scale. This is a specialized product for a small market for families that have teenagers that need insurance.

These inconsistent views on the price forced the team to return to the overall objective of the project in a double-loop sense (Argyris & Schon, 1996). It is interesting to note that while members perceived little value in working closely together, the project still created learning episodes. This was expressed by one informant who stated that if the team had been engaged in more discussions this conflict in price would have been avoided. It seemed that the modular workflow, while effective in one respect still created a disconnect between members regarding assumptions and understandings.

Performance. In the larger picture, the price disagreement (double-loop episode) was settled with a compromise, and the team was able to move forward and launch the product on time. Interviews with several team members and the project manager post-launch indicated a general agreement on the high quality of work and positive feedback from the steering committee was viewed as a success.

In sum, in modular TBKW, there is more room for individual discretion given the high level of distributed knowledge. However, the well-structured nature of the problem makes the knowledge production exploitative with occasional learning episodes, where individual contributions are pooled.

Emerging TBKW: Project E-Letter

A second team from the Swedish insurance company carried out a comprehensive re-design of an insurance letter format used for all correspondence with customers. The E-letter project was characterized by a collaborative effort to reach the project's goal using a co-located team that was closely knit . However, the project did not require a diverse set of expertise from different functions but required more continuous discussions to move the project forward. The required expertise for the project members was a good understanding of the insurance business. While the project was initially viewed as relatively well-structured, as the project progressed, it became increasingly ill-structured as there were no clear project path to follow. There was no previous "lessons learned" or documentation on how to structure and manage this project. Issues and confusion became a constant part of conducting the work. As a result, the project manager and the other members worked in a reciprocal manner (Thompson, 1967). That is, the workflow was marked by members being immersed in the tasks together trying to work out challenges as they occurred (see Figure 4). Moreover, there were few formal roles that separated each person's responsibilities and new tasks were assigned to members depending on their availability rather than their expertise. Taken together, the team was viewed as ill-structured having low distributed knowledge

All team members had a good understanding of marketing aspects and a general grasp of the insurance business. This appeared to enable the team to develop a working relationship with clearly understood norms of when to use communication tools such as email, phone and face-to-face interactions. Some tasks were clearly better suited for specific members, yet the individual tasks tended to blur as others

were heavily involved in each decision made for individual tasks. Steve, a team member explained:

> In our project, everything we do is up for discussion. We can't really pick one person to do a specific task without getting input and discuss with others, which forms the nature of the workflow.

Knowledge Sharing. Sharing of knowledge was essential for the project and members estimated that they commonly interacted over ten times in one form or another on any given day. As David, the project manager explained:

> We don't sit in our rooms by ourselves, we have good communication in the project. We communicate both during lunches, but also specific, in this type of project that is very creative and you need to develop new things, we have a lot of discussions in meetings or if you run over the hallway to someone because you have a question an idea in some form. There is a lot of a "creative mass" in this project that requires discussions as a team.

Knowledge Creation. The team used different forms of interactions beyond simply formal team meetings and informal discussions. One of these was 'coordinating meetings' where members updated each other on the progress and status (a form of knowledge sharing) of the project. These meetings occurred in formal pre-scheduled team meetings. The other form was a workshop type of interaction including actual team level work explained by Cecilia, a team member:

> Workshop mode is a form of face-to-face meeting where ideas are discussed back and forth. We don't really have an agenda and all individuals are expected to pitch in with their perspectives. Team meetings is a different form of meeting where there is a clear agenda with a team leader in charge of the meeting. It involves more reporting, updating and coordination. It's of course possible that team meetings can turn into workshop modes regarding some questions but not the other way around. It's similar to a brainstorming format.

The difference in interaction between workshop mode and coordination was further observed in several team meetings. It was evident that coordination was not an act of creating new ideas or solving a problem but rather a purely administrative knowledge sharing activity. Once workshop mode occurred, the dynamics changed dramatically to a highly interactive almost chaotic interaction where members freely offered their perspectives and listened intensively to each others' suggestions. This workshop mode could focus on either minor changes (exploitative) or foster novel approaches in an explorative fashion.

Single- and Double-Loop Learning. The project faced many challenges including identifying, understanding and prioritizing tasks that would make the project successful. The team members often expressed in interviews that they had no previous guidelines or documentation that could help them structure the project. The lack of prior knowledge also resulted in miscalculations and overestimates on the simplicity of tasks. As new issues and tasks emerged, the project became increasingly complex. Each task that surfaced had to be prioritized and many times decisions made were changed as the project evolved. It is interesting to note that since roles and responsibilities were not well understood, members had to take on tasks that they were not necessarily comfortable with but given time constraints simply had to be done.

Single-loop learning transpired almost on a daily basis. However, frequent interactions seemed to reduce the likelihood of major problems. Minor modifications allowed a continual flow of ideas and addressed problems as they occurred. Double-loop learning transpired several times. One episode involved collaboration with a

support team (IT) due to communication problems. The team spent an entire workshop (a three hour meeting) working to determine why this happened and it was concluded that the team had not been updating the support team about the most current changes and decisions. As Erika, another team member, explained:

> We really had to work things out. After three hours or so, we came to the conclusion that we needed to change the work process where a representative from the support team was physically present in team meetings on a regular basis.

Performance. In the end, the project was delayed by six weeks. This was in large part attributed to bugs in the new software system which was purchased from an outside vendor and beyond the control of the team. Despite the delay, however, the steering committee assessed the project and concluded that it was still viewed as a success given the complexity of the project.

In sum, in emerging TBKW, all three knowledge processes are used. There is an emerging form of a collaborative team in a reciprocal manner where the team engages in frequent explorative knowledge creation and frequent single-loop learning episodes.

Collaborative TBKW: Project Green Light

The final case in the study involved designing a novel standalone medical device to assess skin conditions via light sensor techniques. The team, from a large US-based consumer health product company, was a large highly cross-functional one composed of 18 core members with different but complementary knowledge. At the core were engineering people that had experience with imaging technology,

R&D, marketing, IT, and a few external vendors (product design, manufacturer,). The core team was mostly located on one site although engineers and product development were located five minutes walking distance away in a different building. The IT, marketing, and finance persons were located in the same building but on different floors. The product design person was located overseas at the site responsible for the manufacturing of the project. There were also several external "vendors" located off site. Thus, the project was characterized as ill-structured with high distributed knowledge.

Members' roles and responsibilities for knowledge activities were clear at the onset but tended to blur as the project progressed. This blurring of roles and responsibilities created a need for constant updating and alignment, which proved very difficult. Mary, the product development manager highlighted this in an email discussing the team charter with Richard, the project manager:

> A number of these tasks [in the team charter] do not have successors but let's not worry about that right now. Once you provide updated status, we can review missing successors on the 24th.

The team struggled to keep functional roles stable; however, some members acknowledged that roles at times could change, as the Lisa, the marketing person explained:

> I know my role but there has been a lot of evolution, part of it was not clear. It's a new product that we built from scratch so it's impossible to know everything from the start. It's like an organic, growing process.

The project faced many challenges, due in part to the many sub-tasks that needed coordinating. Moreover, team members constantly underestimated the time necessary to complete their individual tasks. One informant stated that "the scientists that are

working on this project are not used to working on deadlines. They have no idea how to turn a concept into a functional product." A contributing fact was the lack of knowledge about the processes needed in the project. Members expressed in several interviews that having a clear understanding about one's role would help them guide the tasks and improve efficiency, yet, when pushed on this issue, members acknowledged that it probably was impossible. The nature of the problem and the high distributed knowledge in the team resulted in a highly complex reciprocal interdependence illustrated in Figure 4, where the length of the arrows indicates this increased complexity compared to emerging TBKW. All three knowledge processes were frequently used and will be analyzed next.

Knowledge Sharing. The workflow in the project was characterized by complexity and close collaboration. Members were constantly reaching out to each other to discuss questions and problems which created a highly reciprocal workflow as Richard explained:

> The team is very de-centralized where members work closely together. This is a very complex project and you need people to work closely with the task at hand. My role as project manager? Well, I can't know everything, that's why team members need to work together.

Most members were located in different buildings on the same site; however, email was a significant form of communication. One informant stated that "this company has a strong email culture, I would say that 70 percent of the work in this project is done by email" Yet, daily physical informal and formal team meetings were central mechanisms allowing the team to function and fill in and clarify missing information or confusion. Moreover, at times when members exchanged a series of emails during a short time, emails appeared somewhat inefficient. One informant

recalled several occasions this occurred: “we were sending five-six emails back and forth, and I eventually said, wait, this is silly, I’m coming up to you!”.

Knowledge Creation. Similar to the E-letter project, this project engaged in both coordination and workshop modes several times per week. The coordination meeting occurred on Mondays and were held FTF and included the entire team where even the highest level of members participated (the VP’s of each function). The content discussed was mainly updates and new directions for the project and was facilitated by an agenda circulated in an email prior to the meeting. Workshop meetings held on Thursdays were much smaller in terms of members and highly action oriented. The attending members were only the most relevant ones that could add value to a particular problem. The formats of these meetings were strikingly similar to those observed in the E-letter project, characterized by intense debates and problem solving for a particular problem or issues face by the team, which could be either exploitative or explorative in nature.

Single- and Double-Loop Learning. Double-loop learning occurred frequently, which at times created additional workshops meetings. It seemed almost a necessity for the project given its ill-structured nature that required a wide knowledge base. Reflection and updates about the purpose and scope of the project became part of the work itself. Alexander, the IT manger, explained:

> The team acknowledged the problems of poor alignment. As a result, we sat down as a team and put things on a piece of paper on May 15th. I just had to go back and refer to something we had decided and say – on May 15th we decided xyz. At the end of that day, the key to this is to make sure that we review this periodically and that as things change, we need to constantly update as we have many conversations. Within a day, that plan we developed was obsolete, we were making agreement and changing dates, re-prioritizing, and not updating the document. A month

> later, we sat down again and revised the document. The main problem is the countless informal conversations on the side between two people that may have lunch together. They make a decision without informing the rest of the team.

Performance. The assessment of the team's performance was considered high based on the feedback from the steering committee. When discussing the performance with the informants in the team, a general consensus was that the novel product that had been designed, tested and launched with a short timeframe was a success.

In sum, in collaborative TBKW, the team is characterized by a complex reciprocal workflow where each team member's actions and thoughts are in constant motion in a complex social reciprocal workflow. The nature of the work involves both exploitative and explorative knowledge production and frequent learning episodes.

Survey Data. While comprehensive statistical analyses were not possible given the small sample size of four teams, the trend summaries are still informative and lend further support to the qualitative findings. Figure 2 illustrates each team's mean value of structure of the problem and range of distributed knowledge. Each 7-point Likert scale was summarized and averaged. Specifically, the scores for the Greenlight project team indicate relatively high distributed knowledge and an ill-structured problem (14 and 30.25 respectively); scores for the E-letter project indicate low distributed knowledge and an ill-structured problem (22.33 and 10.3 respectively); scores for the Start project indicate high distributed knowledge and a relatively well-structured problem (13.3. and 17.66 respectively); scores for the Wheelbase project indicate both low distributed knowledge and a relatively well-structured problem (8.4 and 12.0 respectively). E-letter and Wheelbase are low distributed knowledge but have scores of 22.33 & 8.4 while Greenlight and Start are high knowledge and have

scores of 14 & 13.3, in between the scores of E-letter and Wheelbase. A similar problem occurs with the structure scores. Figure 3 illustrates the mean values of each knowledge process collected from the web-based survey (knowledge sharing, knowledge creation and team learning) and supports the proposition developed above that both Emerging and Collaborative TBKW require more knowledge sharing and knowledge creation. It also indicates that learning episodes are more frequent in both Emerging and Collaborative TBKW compared with both Modular and Standardized TBKW.

Figure 1
Structure of Problem and Distributed Knowledge Across Teams

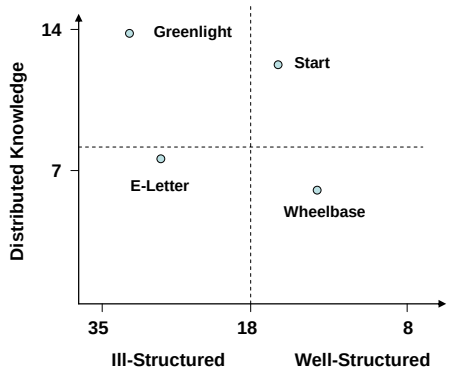
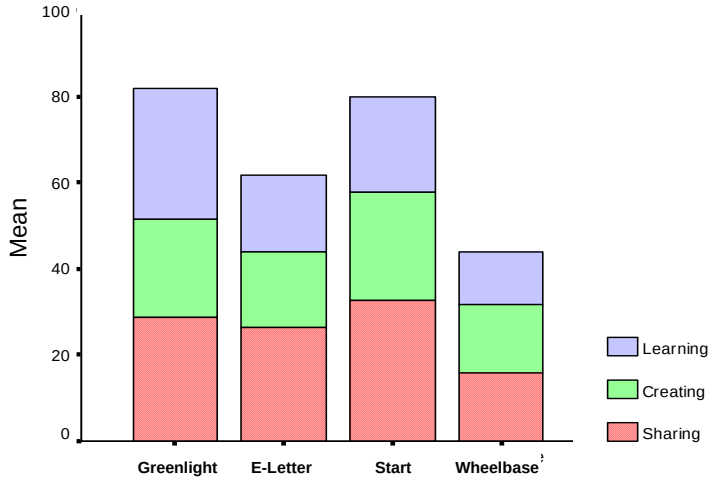


Figure 2
Levels of Knowledge Activities Across Teams

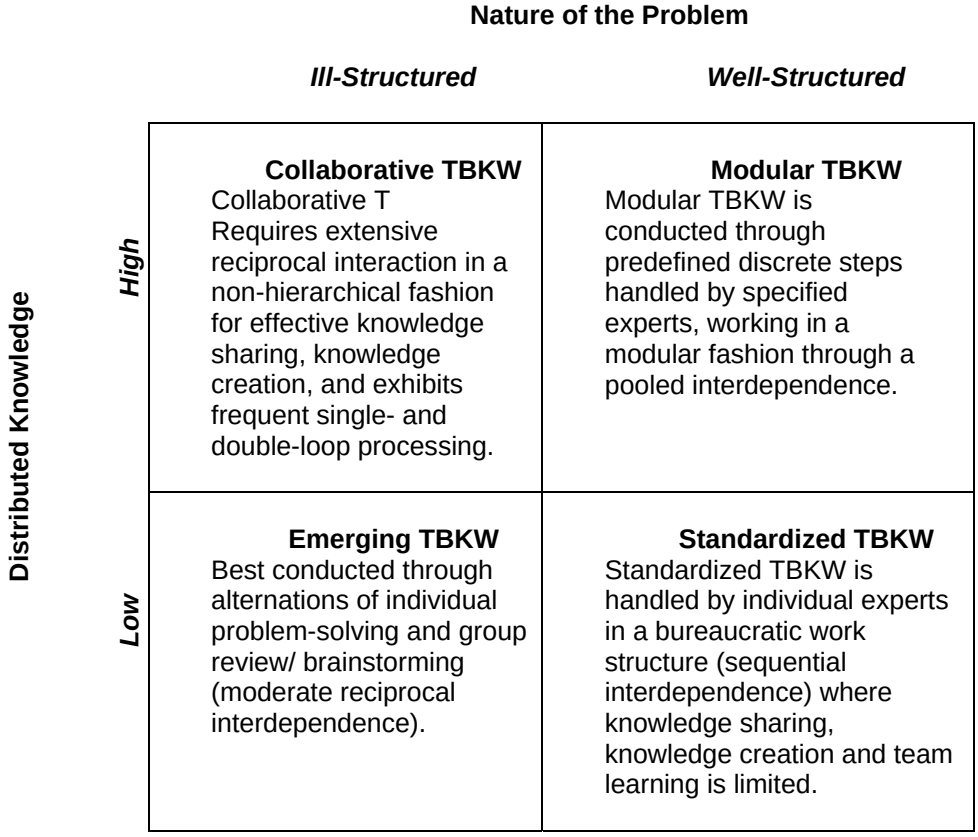


DISCUSSION

The goal of the current paper was to offer a grounded theory of the dynamics within four different types of TBKW. Drawing on extant social and managerial theory as well as the fieldwork data outlined above, I offer a contingency theory below on ideal forms of team-based knowledge work. The theory rests on two key factors to understand the dynamics: 1) the structure of the problem and 2) knowledge distribution for explaining four types of TBKW: standardized, modular, emerging and collaborative TBKW depicted in Figure 3. Each quadrant offers a proposition of the dynamics we would expect when combining the two key factors.

Figure 3

Four Ideal Types of TBKW: Structural Problems and Distributed Knowledge



Towards a grounded theory of TBKW

Standardized Team-Based Knowledge Work. Standardized TBKW requires little distributed knowledge and is well-structured (lower right quadrant in Figure 3). This parallels Weber's (1947) seminal work on bureaucratic organizations (lower right quadrant in Figure 1). In short, Weber pointed out that effective bureaucratic organizations operate based on a set of principles where roles and responsibilities are clear and stable over time. Reporting relationships are hierarchical in nature, with limited or no interaction across functional lines. Each person involved in the process

holds specialized knowledge to carry out his/her job and conducts limited lateral interdependent work. Communication is commonly done in a vertical fashion between supervisor and subordinate.

While the bureaucratic nature of this type of work may seem dated, it still is a highly effective way to conduct work in stable and predictable contexts (Burns & Stalker, 1961; Heckscher & Adler, 2006). In stable situations, as seen in the Wheelbase case, work does not generally require on-going learning or knowledge creation beyond the individual's responsibilities. Roles and responsibilities are predefined, which in turn reduces the need for close interactions (Olson et al., 1995). Moreover, in a bureaucratic fashion well-structured involves limited combinations of various perspectives (i.e. knowledge), and the use of teamwork is not required in its usual sense. In standardized TBKW, there is no real purpose in interaction since it would only tend to slow down each person's task if regular team meetings are held. However, in contrast to 'traditional bureaucratic' systems where rules are coerced in form of control and punishment, in standardized TBKW, members have some leverage in applying individual knowledge to address minor discrepancies and deviations within their content domain. This is possible to the extent members understand their role in the larger picture in an enabling bureaucratic sense (Adler & Borys, 1996).

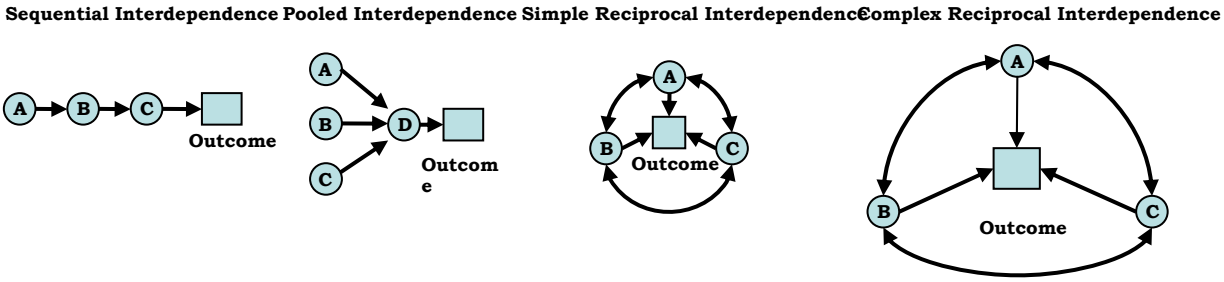
Important to point out here is that standardized TBKW still involves knowledge. Weber built his theory of bureaucracy largely on its ability to organize expertise, in the sense of the autonomous application of expert knowledge, that is, individual knowledge creation. The actual work carried out in bureaucratic teams is highly

individualized based on their functional position but is limited to an exploitative knowledge creation (March, 1991) – incremental changes to existing products, processes or services. Once a task is complete, it is "thrown over the wall" to the next person to continue the work where the last person left off. While the entire process of knowledge production may include various knowledge domains, as observed in the Wheelbase case (i.e., the engineer, sales person, manufacturer, and the knowledge integrator in project Wheelbase), it is the handoff of individual contributions that makes this form of TBKW low in distributed knowledge. That is, knowledge exchange is limited to a one-way sequence. The focus on individual contribution along with a limited need for lateral interaction renders closely knit teamwork ineffective.

Learning as a form of adjustment generally results from errors or unforeseen problems and is prone to occur when decisions are made in ill-structured contexts as discussed earlier. Although learning is an important aspect of knowledge work, highly standardized work, where limited creative decisions are needed, would tend to reduce the incidence of errors and subsequent learning episodes. In stable environments, (i.e., bureaucratic ones), this work structure is effective simply because it has established and perfected processes to eliminate errors.

Conceptually, standardized TBKW resembles Thompson's (1967) notion of *sequential interdependence,* where each task is carried out in a sequential order, much like an assembly line production. Since the work is highly structured and predetermined, this sequential interaction makes it highly effective in stable conditions. Figure 4 on the far left illustrates this type of interdependence.

Figure 4
Interdependence in Team-Based Knowledge Work



Note: Letters denotes different team members

Modular Team-Based Knowledge Work. Modular TBKW (upper right quadrant in Figure 3), the second type, is similar to standardized TBKW but invovles greater distributed knoweldge (e.g. Clark & Fujimoto, 1989). These teams, as observed in the Start project, are perhaps best categorized as modular work structures (Schilling, 2000). Modularity is a notion used to describe work structures that have a high degree of independence or "loose coupling" between functions or tasks (Sanchez & Mahoney, 1996; Gittell, Kautz, Lusenhop, & Weinberg, forthcoming)). Modularity by its very definition requires clear roles with clear purposes and tasks that are clustered into modules (subsequent or parallel work streams); work is based on a clear division of labor where each member is assigned tasks based on his/her expertise.

The dynamics in modular teams are characterized by individuals brought to the team because of their unique knowledge. This was the case in the Start project where

Product development, Marketing, Internet, IT, Sales, and Training representation were combined to modify and implement the youth insurance. However, since the tasks are clear and rooted in each person's subject areas, there is little need for close interaction, which would perpetuate a modular work structure.

This form of interdependent teamwork resembles Thompson's (1967) notion of *pooled interdependence*, where the individual contribution is accomplished individually rather than as part of a closely knit team. What makes this form of TBKW interdpendent is the individual actions, rather than thoughts, that are orchestrated to form a final outcome. Individuals rarely influence each other by the way they think, reflect or approach individual problems; rather, team members' actions or the product of their individual thinking is simply merged at key milestones in a project where each contribution is 'pooled'. This is depicted in the second model in Figure 4.

In contrast to standardized TBKW, this interdependence in action creates a need for coordination given the high distributed knowledge (Sanchez & Mahoney, 1996; Eppinger, et al., 1994). Distributed knowledge implies that members conduct very different tasks linked to their individual expertise. Work must be aligned with the others' tasks which cannot occur in a vacuum. Thus, the main flow of activities is coordinated via a central mechanism (i.e. a project manager) and impacts the workflow into a more centralized fashion.

Although the workflow may be more centralized in modular TBKW, it is also less hierarchical than standardized TBKW (i.e. bureaucratic). The rationale for this seemingly paradoxical relationship is that each person's status is based on the

contribution in the respective subject domain rather than on position, tenure or status. In standardized TBKW, positions are emphasized and status dictates who makes decisions. In modular TBKW, the decisions and work structure are guided by the knowledge held by each person.

Similar to standardized TBKW, errors and mistakes would be kept at a minimum given the nature of the problem. That is, as the effort and ability to define structure and formalize the project increases, one would expect fewer errors. Therefore, it would seem plausible that the occurrence of either single- or double-loop learning would be minimal simply due to the clarity of the project.

Emerging Team-Based Knowledge Work. Emerging TBKW – involving ill-structured problems, but relatively low levels of distributed knowledge (lower left quadrant in Figure 3) – is seen mostly in autonomous teams (e.g. Hackman, 1990; Cummings, 1978). Autonomous teams have been studied in depth in various fields (e.g. Cohen et al., 1978; Rubinstein, 2000) and are characterized by members involved in interrelated tasks responsible for making a product or a service, having discretion including task assignment, methods, scheduling and responsibility for the end products (Wall, Kemp, Jackson, & Clegg, 1986).

In contrast to standardized and modular TBKW, emerging TBKW is better characterized as teamwork because it involves the interactions necessary to address the ill-structured problem faced by the team as observed in the E-letter project. The work structure is marked by an iterative process of individual contributions and teamwork. The process resembles “normal” traditional science in a “Kuhnian” sense, whereby a scientist works independently (i.e. creates knowledge) and then presents

his ideas in a social setting, in front of peers to brainstorm to gain input to further develop the work (Holton, 1996). This feedback can occur in formal settings but also in more informal discussions outside team meetings. Moreover, emerging TBKW is generally confined to a specific knowledge domain given the low level of distributed knowledge required for the problem. The focus is to invest the time necessary to consider all possible options together with the relevant experts within that knowledge domain rather than incorporating subject matter experts from other functional areas. In the E-letter project, the task was to develop a new generic insurance letter to fit all existing polices and clients that did not require cross-functional expertise.

Interactions are central to emerging TBKW given the ill-structured work where members have to define, discuss and assign individual tasks for next steps. Team members must share and support knowledge creation both at the individual and team level. The iterative process of knowledge sharing to spur new ideas and actions is necessary in order to successfully reach the team's objective. This interdependency is what Thompson (1967) referred to as *reciprocal interdependence*, where both action and thought colors the individual's contribution to the team and depicted in the 3rd model in Figure 4. Moreover, interactions serve as an important mechanism to maintain a shared understanding about the progress of the project (Van de Ven, Delbecq & Koenig, 1976).

Learning episodes commonly occur in ill-structured contexts, that is, where much of the work is novel and evolving. While novel work involves frequent adjustments, what may moderate the occurrence of major errors is low distributed knowledge. Low distributed knowledge allows members to share similar views and as a consequence,

better align members' actions (Olson et al., 1995). Moreover, close collaboration facilitates detection of errors that can be addressed and evaluated on an on-going basis, which suggests that errors can be addressed before they turn into significant learning episodes.

Collaborative Team-Based Knowledge Work. Collaborative TBKW – involving ill-structured problems and a high level of distributed knowledge – parallels Adler and Heckscher's notion of collaborative community, which extends Durkheim's (1997[1933]) seminal work on organic solidarity. They argued that highly distributed knowledge is essential in new forms of team-based organizations and is what holds teams together. In other words, it is the increased reliance on other's knowledge that creates a need for mutual and close interdependence. Similar to emerging TBKW, a central challenge in collaborative TBKW (upper left quadrant in Figure 3) is to understand the nature of the project, in a sense, to make an ill-structured problem more structured in order to solve it. This iterative process of refining the project resembles Weick's (1993: 635) notion of "sensemaking". The basic idea of sensemaking is that "reality is an ongoing accomplishment that emerges from effort to create order and make retrospective sense of what occurs...[it] emphasizes that people are trying to make things rationally accountable to themselves and others…it is built out of vague questions, muddy answers, and negotiated agreements that attempts to reduce confusion". In other words, sensemaking in the context of collaborative TBKW implies that not only the project itself is made sense of, but also the individuals' roles and responsibilities are established during dialogs among team members (i.e. knowledge sharing). It is a process that requires iterative

development of members' ideas and perspectives to shape and structure the project towards its goal (i.e. knowledge creation).

What amplifies this sensemaking processes and the need for close interaction in Collaborative TBKW, in contrast to Emerging TBKW is that it it has a wider knowledge base in the team as observed in the Greenlight project, which involved building, designing and launch a novel, stand alone medial device to assess facial skin condition/damage.

Generating a shared understanding about the nature of the problem across expert domains is an inherent challenge as members differ in their perspectives, languages and priorities which require additional efforts to interact (Heckscher & Adler, 2006). In order for collaborative TBKW to function properly there is an inherent need for frequent interaction in a *complex reciprocal fashion* were members' actions and thoughts are in constant flux (Thompson, 1967). The high distributed knowledge makes close interaction even more important, as symbolized by the longer arrows in the model on the far right in Figure 4.

Similar to Emerging TBKW, these intense interactions are further facilitated by minimized status differentials and less formal rules (Hickson, Pugh & Pheysey, 1969). In other words, there is less emphasis on authority supervision and more emphasis on empowerment and team discretion. In contrast to bureaucratic work, rules and status differentials would tend to slow down the work process and reduce the collaboration necessary to build on individuals' perspectives and ideas.

Combining both highly distributed knowledge and an ill-structured problem means that the team is heavily involved in single- and double-loop processing. A

member's contribution must be identified and aligned, which is increasingly challenging when the project is not very well structured. A novel project without any previous understanding as to how it would best be addressed, requires the team to make assumptions and satisficing decisions (Simon 1959) that are likely to be less than optimal. In conjunction with role confusion and poor boundaries outlining the project, the double-loop process is a frequent event and, in effect a necessity to move the project closer to its end goal.

TBKW Fluidity

The framework developed here assumes that the nature of the problem and the knowledge linked with the project are fixed. This is a common limitation in the contingency literature, which may not be an accurate reflection of the reality and deserves more attention here (Moon, et al., 2004). As teams gain additional understanding about the problem, the work structure may evolve and activities take shape making an ill-structured problem less ambiguous, resulting in additional knowledge mobilization located outside the current teams' membership.

Fluidity and Structure of the problem. During the fieldwork evidence indicated that the structure of the problem tended to shift depending on the stage the team operated in which has been supported elsewhere (Nemiro, 2002). In other words, this "fluidity" of moving from one quadrant in Figure 3 to the next was generally tied to a temporal dimension of project life. This was especially the norm in collaborative TBKW and is consistent with Weick's (1993) theory on sensemaking. That is, what determined whether the problems were well- or ill-structured was the process of

sensemaking. It is also aligned with practitioners' aim for structure and efficiency in order to make satisficing decisions (Simon, 1959).

The closer to the end of the project, the better clarity the team generally reported which was tied to the success of the project. Without being able to make the project less ill-structured in a sensemaking way, the project was prone to make mistakes, creating learning episodes which subsequently delayed key milestones and ultimately the performance of the project. Since "hindsight is 20/20" most projects in the end had solved the structure of the problem, or at least established a shared understanding about the problem and the overall objective. Success seemed conditional upon the teams' ability to impose boundary conditions on the problem and deliver a final outcome. Yet, this outcome was not straightforward. Team members' reflection on the path to clarity was hobbled by shared confusion and on-going discussion about the real purpose of the project particularly for Emerging and Collaborative TBKW.

While all project teams in this study experienced confusion and uncertainty at some point, they did so to various degrees. Clearly, Greenlight and E-letter project experienced more uncertainty and faced more difficulties in framing the problem and developing processes to assure project success. Project failure is a common occurrence (Donnellon, 1993). Interesting to note is that the four projects studied here were all successful in the end. One might speculate that in cases where teams were not able to reduce the ill-structuredness of the problems, they may have ultimately failed and been terminated. In addition, issues identified in the extant team literature such as personal differences, conflicting priorities, communication differences, lack of trust (Jackson, Joshi & Erhardt, 2003) resulting in increased cost and resources,

and the challenge of reaching clarity may serve as a potential explanation for these failures.

While moving from ill-structured to "better-structured" problems tended to be a function of the life span of the project, the evidence indicated that the reverse could occur. As a team gained clarity regarding the central challenges, the problem could mutate into a more complex ill-structured one. This was the case for the E-letter project (Emerging TBKW). Re-designing the company's insurance letters that were linked to a new information system appeared straightforward at the inception of the project. However, as the project took form, various issues emerged making the project increasingly ill-structured. The team jumped into the project addressing each task as it emerged. Turning a paper based letter system into a non-paper based information system proved a highly complicated process. Each letter for different types of insurance had different formats, styles and content, which made creating a standardized information system complicated and anticipating all steps in the process virtually impossible. Informants stated that this was mainly due to the novelty of the project which had never been attempted before. Moreover, the information system developed and purchased from an external provider was new and even the vendor providing it did not know how it would work and integrate with existing systems already in place in the company.

Fluidity and Distributed Knowledge. The composition fluctuation of the team's knowledge on all projects except the standardized form of TBKW (lower right quadrant discussed below) added a second dimension to the fluidity issue. It was apparent that as the team moved forward in the project, team members reached out

within or beyond physical boundaries to access and integrate key subject matter with relevant knowledge for the task at hand not anticipated initially. When asking informants about this issue, many stated that they had all relevant knowledge for the task, but, a few months later, additional members had been added to the team. This may at first be viewed as a sign of poor performance. However, fully anticipating the range of expertise needed seemed virtually impossible in ill-structured work; figuring out what and whose knowledge should be part of the team appeared a central aspect of conducting the actual work of TBKW.

Interesting to note is that this fluidity of knowledge was mainly driven by team learning processing. When teams faced a problem, at times the current members were not able to fully solve the problem. The Start project team was a case in point – they realized additional knowledge from the Internet function was necessary to handle the tactical issues of posting material on-line. Moreover, the E-letter project faced similar challenges. Perspectives and knowledge necessary to the team was not completely present at the beginning, which created challenges for the team later on.

Distributed knowledge could also operate in a reverse fashion. As a project moved from one stage to the next and a member that was essential in the beginning may have become superfluous later on and departed from the team. The Greenlight project is a case in point. The project was initiated by the research function, where several scientists worked on developing and perfecting the image sensory technology used to assess a person's skin condition. Once this technology was working properly, the scientists' task was essentially completed and they were kept on an "informed basis". However, there were several instances where the sensors did not operate

accurately during the trial in the field, and the technical scientists were brought back until the problem was fixed. The point here is that membership and knowledge in the team fluctuated depending on the task at hand. Again, errors (i.e. learning episodes) appeared a central driving mechanism for understanding this fluidity of distributed knowledge in the team.

In contrast to the other three projects, the Wheelbase project (Standardized TBKW) did not vary with respect to the knowledge and structure of the problem. Discussions with team members indicate that the standard processes in place to organize the project provided limited room for errors or deviations. The project was founded on structure and rigor, a principle adhered to in any project in the company. All relevant members and roles were identified *a priori* and had been established over repeated and perfected processes during past projects. An operating principle for the Wheelbase company was that projects were not executed unless they could be adopted to existing work processes. That is, unless clarity could be established and subsequent knowledge existed within the boundaries of the company, a project would not be launched. It would simply be deemed “too complicated or too risky”.

The fixed non-fluid strategy to develop new products may be inherent to the nature of the work. However, the Greenlight project indicated very different fluidity in terms of knowledge and structure of the problem. An alternative and more plausible explanation is that the clear problems along with low distributed knowledge do not create fluidity alone. The fluidity appeared to become a factor when one of the two contingency factors was high. In other words, if the nature of the project has high

distributed knowledge and/or the team is faced with an ill-structured problem, it is more prone to experience fluidity.

Implications, limitations, and future research

The study is based on a limited number of cases which suggests caution in terms of making strong conclusions. However, the findings generate theoretical implications important to address. Although the members may perceive themselves as a team, the *modus operandi* in both standardized and modular TBKW are characterized by loosely coupled teams where the structure of the problem is clear and well understood *a priori*. Well-structured problems allow teams to divide up tasks depending on individual time and expertise, whereby each member engages in minimal interactions amongst themselves. In line with Olson and colleagues (1995), the qualitative data suggest that this is an effective way to structure work during well-structured problems, where efficiency is maximized by standard rules, clear task responsibilities and stable working conditions. In other words, closely knit teams did not appear to be an optimal form of work structure when problems are well-defined. In contrast, ill-structured problems turn the absence of interaction on its head. Without extensive knowledge sharing, teams facing ill-structure problems had difficulties conducting their work. Knowledge creation became a social process where input from other members was essential. Moreover, having to make assumptions and decisions based on incomplete knowledge seemed to trigger errors and mistakes, which made social knowledge processes fundamental in TBKW.

The fluidity of types of TBKW raises questions about the usefulness and appropriateness of the 2x2 ideal types of TBKW. It is important to note that this

framework is meant to be applied in a Weberian sense, providing a useful lens as to how various form of TBKW may be organized and explaining the dynamics within. Notwithstanding the apparent fluidity in three of the four projects studied, the general categorization into each quadrant still remains valid. For example, the problem for the Greenlight project became more structured as it progressed. However, it never really reached a similar degree of clarity as, for example, in the Start or Wheelbase projects. When asking informants from the Greenlight project to compare it to other projects they had been involved with, the consensus was that it had been a highly ill-structured project. Moreover, distributed knowledge ranged in degrees during the life span of the projects, as new members would come and leave depending on the relevance of their expertise. Finally, while membership tended to fluctuate across projects, most of the core team members tended to be fixed. Accordingly, the core team membership allowed an objective assessment as to the general level of distributed knowledge existing in the four ideal types of TBKW.

Interesting to note is that the structure of the problem and distributed knowledge are two distinct but highly linked issues in TBKW. As the clarity of the project increased the team also could better determine what knowledge was necessary for the problem. What is not clear, however, is to what extent greater distributed knowledge in the team would facilitate more clarity of the problem. The diversity team literature assumes with the "added diversity" argument (e.g. Richard, 2000) that more knowledge would facilitate more approaches and presumably more options and ideas to address a problem. However, the key point in this study is that the task at hand must be linked with relevant knowledge. Simply having more knowledge that is not

relevant may detract from the task and even reduce team performance. More research is needed to further explore the extent to which teams can actually oscillate between well- and ill-structured problems and distributed knowledge and the impact on team dynamics.

An important limitation to acknowledge here is one that most qualitative researchers face – the challenge of collecting data from a large enough sample size to ensure the findings are generalizable. However, the purpose of qualitative research is hypothesis building rather than hypothesis testing. Moreover, the focus of this paper has been on the *process* of team-based knowledge work. As such, conformity to the current "variables paradigm" where social reality is parsed into fixed entities and where causality is attributed to these variables is not appropriate (Abbott, 1992). Instead, I used an inductive approach guided by the extant literature to shed light on the dynamics of team-based knowledge work. However, additional quantitative research is needed to further test the proposed framework across teams working in different contexts and companies that may further support or disprove the framework of TBKW developed here.

Another limitation worth acknowledging is the focus here on internal knowledge processes. While I emphasized knowledge sharing, knowledge creation and team learning occurring as intra team activities in the project team, much of knowledge work is likely to include external activities as well, such as knowledge integration, communication and boundary spanning (Ancona & Caldwell, 1992; Argote et al., 2003; Gittell, 2002). Additional research is clearly needed to address these limitations in the current paper.

This paper has offered insight as to how and when teams engage in TBKW. Specifically, the main findings suggest that the structure of the problem and the level of distributed knowledge required for a problem influence the nature and the extent of knowledge processes adopted in TBKW. It is my hope that the framework developed here offers a helpful lens for researchers to further explore knowledge work in teams. While this framework may need adjustments as we continue to move forward in this research stream, it is essential to develop a common body of literature of processes involved in knowledge work.

Table 1
Description of Case Data

Case/ Characteristics	Greenlight	E-Letter	Start	Wheelbase
Objective	Build, design and launch a novel, stand alone medial device to assess facial skin condition/damage	Develop a new generic insurance letter to fit all existing polices and clients	Develop a new insurance policy tailored for a young customer base	Designing a safety feature for industrial use of a sliding mechanism
Case description	Complex novel problem involving a wide range of stakeholders.	A novel project complicated by the many format requirements, printing issues, content making it highly complex task	A well defined objective based on an existing one from Norway	A well defined problem, standard processes, clear roles and responsibilities
Core Membership Representation	Marketing, IT, Engineering, Manufacturing, Finance	Product development, Sales	Product development, Marketing, Internet, IT, Sales, Training	Engineering, Sales, Manufacturing, Knowledge integration
Level of interdependence among members	High	High	Low	Low
Size	12	4	7	5
Time frame	2 year	9 months	6 months	9 months

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CHAPTER 4

DYNAMICS OF TEAM-BASED KNOWLEDGE WORK: EXPLORING THE LINK BETWEEN KNOWLEDGE PROCESSES, OFFICE POLITICS AND MEDIA USE

Abstract

Scholars have traditionally treated virtuality as an 'either-or" phenomenon. However, in complex team-based knowledge work both virtual and physical interactions are necessary whether teams are co-located or geographically dispersed. Drawing on the social shaping view as a theoretical framework, this study explores the link between knowledge processes and social factors motivating media choice in knowledge work. Using data from 91 semi-structured interviews, observations and 402 emails from six project teams in the consumer health, insurance, and engineering industries, grounded theory is developed regarding the link between team-based knowledge work (knowledge sharing, knowledge creation and team learning), knowledge interdependence, political factors (strategic ambiguity and power differentials) and the adoption of media. Media was used based on the complexity of the task and nature of the interdependence. However, at times, political factors undermined these patterns based on individual agendas and power differentials. Theoretical and practical implications are addressed and future research directions are discussed.

Key words: Virtual teams, knowledge work, political dynamics

The emphasis on knowledge coupled with the proliferation of information and communication technologies (ICTs) in the workplace has created greater knowledge interdependence in terms of teamwork (Drucker, 1999; Grant, 1996; Heckscher & Adler, 2006; Kirkman, & Mathieu, 2005; Mohrman, Cohen & Mohrman, 1995). Companies find themselves merging both electronically mediated and physical interactions to leverage individual expertise in interdependent team-based knowledge work (TBKW). That is, TBKW, conceptualized here as a collaborative interdependent *process* of sharing knowledge, creating knowledge and learning, is increasingly being conducted via both virtual and physical means in co-located arrangements involving varying degrees of geographic dispersion (Kirkman, & Mathieu, 2005). Yet, surprisingly little research in the management literature has examined these knowledge processes and the role of different media in complex knowledge work; as Kirkman, Rosen, Tesluk, and Gibson (2004: 175) contend, "studies examining ongoing virtual work teams performing meaningful, complex tasks in business organizations are now needed."

While the use of virtuality, defined here as a technologically dependent activity that can vary in degrees, seems vital for knowledge work, the extant literature on virtual interaction is mixed. On the one hand, virtuality has been linked with team effectiveness in terms of locating technical expertise (Kayworth & Leidner, 2001/2002) and generating higher quality work (Schimdt, Montoya-Weiss, & Massey, 2001; Connolly, Jessup & Valacich, 1990). Moreover, research on experimental electronic group support systems suggests that virtuality increases

decision quality and equality of participation (McLeod, 1992). On the other hand, it has also been linked with negative process losses such as inefficiency (Straus & McGrath, 1994), less frequent communication (Straus, 1996), lower quality decision making (Hedlund, Ilgen & Hollenbeck, 1998), reduced innovation capacity (Gibson & Gibbs, 2006) and reduced performance compared with teams that rely extensively on face-to-face (FtF) interaction (McDonough, Kahn & Barczak, 2001; for recent reviews see Martins, Gilson & Maynard, 2004; Bell & Kozlowski, 2002). These process losses are often attributed to the challenge of transmitting tacit knowledge and nonverbal cues that assist in reaching understanding (Straus, 1996; Sproull & Kiesler, 1986; Kirkman, Rosen, Gibson, Tesluk & McPherson, 2002).

I respond to the call for more qualitative (especially ethnographic) research on virtual teams in naturalistic settings (Gibbs, Nekrassova, Grushina, & Abdul Wahab, forthcoming) by adopting a qualitative approach to gain a richer understanding of knowledge processes and media use in TBKW. A qualitative approach is well suited for exploring new contemporary concepts that are grounded in the workplace that are not conducive to investigate through traditional quantitative methods (Miles & Huberman, 1994). By shedding light on the use of media in knowledge work, I add to the literature by building grounded theory as to how and when various knowledge processes are used in the context of team dynamics. The paper is organized by first discussing the conceptualization of team virtuality, followed by a discussion of three central knowledge processes and their link to virtual and FTF interaction for TBKW effectiveness.

CONCEPTUAL BACKGROUND

Team Virtuality

The notion of team virtuality is commonly defined based on the practice of working across space and time through various electronic means in various degrees of synchronicity, or the ability to collaborate on the same activity at the same time (e.g. Bell & Kozlowski, 2002; Walther & Parks, 2002; Dennis & Valacich, 1999). I define team virtuality as a technologically dependent activity (to varying degrees) to mobilize knowledge that includes members who range in their degree of geographical dispersion.

This conceptualization assumes the need to transcend the dominant "either-or" conceptualization of technology use to understand TBKW dynamics.

Scholars have found that teams use different media during different stages in a project's life (Kristensson & Norlander 2003; Ocker, Fjermestad, Hiltz, & Johnson, 1998; O'Sullivan, 2003). Maznevski and Chudoba (2000) found that different types of interactions were used based on the function and the temporal rhythm of the project. For some activities such as the initiation of the project, FtF meetings seem highly desirable to establish trust and shared understanding (O'Sullivan, 2003). Several media can also be mixed and combined to address a single issue. That is, a question may be discussed via email followed up by a telephone conversation, or vice versa. This fusion of media is a central issue in the present study that raises important questions for the dynamics of TBKW.

Social Shaping View

The social shaping view suggests that not only features inherent in the technology itself, but also social factors, shape interactions. The technical factors in an

organization theory (OT) sense refer to the *processes* required to transform inputs into outputs (Robbins, 1989). If we extend the technology metaphor and apply it to knowledge work in teams, it involves the knowledge processes that convert inputs (existing knowledge) to outputs (new knowledge). Social factors emphasize social pressures, norms, and values that influence how technologies are used (Ellison, Heino, & Gibbs, 2006; Dutton, 1996; MacKenzie & Wajcman, 1985). Both technical and social factors are closely linked and impact each other in a manner that may not always be expected from an assumption of rationality (Dutton, 1996); members of a team may deliberately choose a synchronous (i.e. via FtF and phone) or asynchronous media (i.e. via email) with the intention of impacting the clarity of the message for personal or political reasons.

Knowledge Processes in TBKW

Knowledge is the underpinning for any intellectual work. While an in-depth discussion is beyond the scope of this article and has been examined elsewhere (e.g. Kogut & Zander, 1992; Davenport & Prusak, 2000; Alvesson, 2004; Nonaka & Takeuchi, 1995; Polanyi, 1966), in short, knowledge is broadly defined here as *understanding gained by intellectual and/or practical experience*. The emphasis here is on the actual processes of conducting knowledge work in the context of teamwork. Scholars have made important contributions to identify key knowledge processes including knowledge sharing (Bock & Kim, 2002; Zarraga & Bonache, 2003; Argote, McEvily & Reagans, 2003), knowledge creation (Gilson & Shalley, 2004; Leenders, van Engelen, & Kratzer, 2003; Argote et al., 2003), and team learning (Edmondson, 1999; Kozlowski, Gully, Nason & Smith, 1996. These

constitute the foundational processes of team-based knowledge work presented in this paper.

Knowledge Sharing. In line with the conceptualization of knowledge presented above, knowledge sharing (KS) is defined here as *a social non-linear process of exchanging and understanding knowledge*. Sharing of knowledge can range between tacit and explicit knowledge; tacit is generally knowledge that is difficult to express and articulate. Knowledge can also be tacit in the form of unspoken rules and gut feelings. However, once it has been articulated verbally or in writing (i.e. emails), it has become explicit since it is now known among the team members (Nonaka & Tackeuchi, 1995).

Without sharing of understanding (i.e. establishing meaning) among members in the team, be it FtF or virtually, knowledge work cannot be conducted as a team. As Berlo (1960: 52) pointed out, "…the receiver is the most important link in the communication process." Scholars have extended Berlo's seminal work in general transactional models to a more fluid non-linear process (Baskin & Bruno, 1977). The central tenet is that sharing knowledge is a two-way social process whereby members engage in creating mutual understanding. Individuals are simultaneously senders and receivers and the creation of understanding is a mutual process of co-creation. Both parties send and interpret verbal and nonverbal cues to ensure the other is confident that they understand each other.

Knowledge Creation. Knowledge creation is the process that expands on individuals' understanding and creates new knowledge such as ideas, solutions, etc. (Gilson & Shalley, 2004) and can be exploitative or explorative in nature (March,

1991). March suggested that exploration is critical to discover truly novel solutions or ideas. In contrast, exploitation involves incremental refinement and modification of existing products, methods or processes. Both can be viewed as processes of combining knowledge where one mobilizes existing knowledge in new ways and the other mobilizes knowledge through well-understood standardized processes (Taylor & Greve, 2006). It should be pointed out that explorative and exploitative knowledge creation are conceptualized as complementary processes; one does not exclude the other as both are deemed necessary for successful knowledge work and may be pursued during different cycles in the project (see Gupta, Smith & Shalley, 2006 for an extensive review). Drawing on March's (1991) work, knowledge creation is broadly defined here as an *iterative process of producing, developing and implementing work related ideas.*

There is an emerging but limited body of research focusing on knowledge creation in the virtual team literature. Some research suggests that knowledge creation in terms of team innovation is more challenging to conduct via virtual means due to detrimental effects of virtuality features (e.g. Gibson & Gibbs, 2006). Others that have explored the process of knowledge creation indicate that team members tended to get together during key milestones. For example, Nemiro (2002) explored CMC and FtF interaction in various stages of the creativity process and provided important evidence that teams used different forms of interaction depending on what stage of the process the team operated in such as planning and execution, that is, engaging in FtF at early and late stages when all members' perspectives had to be mobilized. Similarly, Kristensson and Norlander's (2003)

study on student teams found support for the importance of FtF interaction in early stages of the creativity process. Researchers have also provided evidence that degree of virtual means is important for creativity. For example, Leenders, van Engelen, and Kratzer's (2003) study indicated that the level of virtual communication could be detrimental to creativity.

Team Learning. Team learning has been conceptualized in various ways including local and distal learning (Wong, 2004), incremental and radical learning (Edmondson, 2002), and cycle of experimentation (Gibson & Vermeulen, 2003). Zellmer-Bruhn and Gibson (2006), drawing on Argote's (1999) work, conceptualized team learning as acquiring, combining, creating and sharing knowledge. Given the many conceptualizations of team learning, Edmondson, Dillon and Roloff (2007) argued that team learning is a useful concept that cannot be thought of as a single specific organizational phenomenon but should focus on more specific learning processes. In line with their argument, team learning in project teamwork here focuses on the ability to adjust as a form of knowledge process, the third and final knowledge process in TBKW. Thus, team learning is viewed here as *a form of team adjustment in response to errors and obstacles* (Kozlowski et al., 1999). That includes both knowledge sharing and subsequent knowledge creation necessary to make the adjustment.

Team learning can vary in magnitude or complexity. Argyris and Schon (1996) referred to this complexity as single- and double-loop learning. Single-loop learning is defined as lower-level learning in the form of on-going small incremental changes that produce successive replacements or refinements of responses. In

contrast, double-loop learning is profound adjustment that includes a change of the theory-in-use; it is the questioning of fundamental assumptions and change in the current framework used to solve a problem that would constitute double-loop learning.

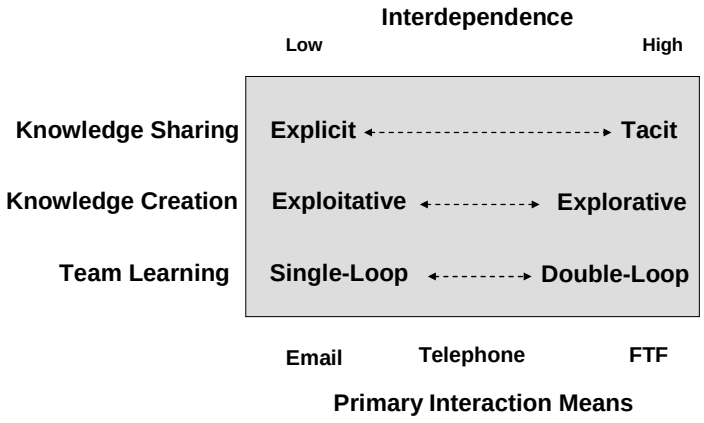
Scholars concerned with learning in virtual teams have typically focused on the challenges with learning. Much research has been conducted in student teams in education (e.g. Johnson, Suriya, Won Hoon, Berret & La Fleur, 2002; Kirschner & Van Bruggen, 2004). Research in the workplace is either studied at the individual level or as a form of team development. For example, Robey, Khoo, and Powers (2000) investigated virtual cross-functional team members' ability to learn new practices from each other to work effectively together. Following the media richness logic (Daft & Lengel, 1984), challenges associated with learning in virtual teams have been attributed to the lack of support mechanisms for nonverbal cues, low participation rates, short discussion threads and so forth (Hakkinen, 2004). Daft and Lengel (1984) media richness theory (MRT) assumes that individuals make rational decisions to adopt a medium based on the richness of the information in terms of 1) feedback capacity (high to low), 2) communication channels utilized (visual, audio), 3) source (personal, impersonal), and 4) language (body, natural, numeric). The logic is that as the richness of the information increases, individuals would adopt a media that allows for more instant feedback (i.e. synchronous). The MRT has been the dominant approach in the extant literature to explain media choice. However, absent in the discussion is the role of knowledge interdependence; defined as the reliance on other's know-how and understanding of who knows what

is referred here to as knowledge interdependence (Wegner, 1989). I argue here that it is the nature of the interdependence that drives the need to interact rather than the capacity of the medium to relay knowledge. As members face double-loop episodes, it becomes increasingly important to access all relevant knowledge that may exist in the team's shared meta memory. Of course, this may force the team to interact more physically since that may help access this wider knowledge base.

Drawing on extant theory, I offer a conceptual framework of the relationship between medium and knowledge processes (i.e. knowledge sharing, knowledge creation and team learning). As the knowledge complexity increases, more interdependence – that is, the need to rely on other members' knowledge – is required, which also requires use of more "live" conversations or richer media such as phone or FtF. As team members engage in more tacit, explorative, and double-loop learning processing, more nonverbal interaction cues become essential. More synchronous interaction is driven by the need to draw on a wider knowledge base at a social (i.e. team) level, but this also helps one access his/her own internal knowledge base (Wegner, 1986). Figure 1 illustrates the nature of the three knowledge processes, highlighting the link between the medium and knowledge interdependence. The need to mobilize each member's know-how becomes increasingly social as the task requires a wider set of perspectives. In other words, as knowledge processes turn increasingly tacit, exploratory and double-looping, the primary media used would be synchronous. The figure outlines a working theory that arranges all three knowledge processes according to complexity. Moreover, it

illustrates a direct relationship between the complexity of the knowledge processes and interdependence.

Figure 1
Interdependence, Knowledge Processes, and Nature of Interaction



With the goal of theory building, the underlying research focus is two-fold. First, I explore how the three knowledge processes are adopted and linked to different types of media. A second aim is to explore TBKW in a social context within the team. Specifically, our intention is to flesh out a grounded theory about the relationship between knowledge processes and social factors influencing media use.

METHOD

Research Setting. I adopted a qualitative case-based approach in order to explore the dynamics of different types of team-based knowledge work. A qualitative approach is suitable for exploring new contemporary concepts that are grounded in

the workplace (Miles & Huberman, 1994). Moreover, a qualitative method lends itself well to explain *why, how* and *when* a complex phenomenon occurs (Yin, 2003). Obtaining access to research sites is notoriously difficult for qualitative researchers. I was able to negotiate access to three companies based on personal connections as well as being a current employee at one of the companies. Data were collected from six project teams from companies operating in Sweden (a large insurance company and a small engineering company) and in the US (a large consumer health product company). The size of the project teams ranged from 5 to 12 members and the teams were in the middle and late stages of their projects. In contrast to quantitative research that commonly adopts random sampling based on statistical deliberations (Miles & Huberman, 1994), these cases were chosen given a set of criteria suitable for the research questions addressed in the study: teams that 1) operated on a project basis with a clear beginning and an end and 2) engaged in knowledge work involving abstract and conceptual work where judgment was central with various degrees of interdependence. In order to assess the validity of the team, the initial assessment regarding the suitability of each case was done by several discussions with initial key contact persons. Each project team is outlined in Table 1.

Insert Table 1
About Here

Data Collection. The bulk of the data was captured via a total of 91 interviews (over 70 hours of recorded data) along with supplemental data such as team

observations, over 400 emails between team members, observations and documents, team charts, and presentations. In most cases, all team members were interviewed multiple times over the project's lifespan. This included several FtF interviews as well as follow-up phone interviews and email exchanges, especially during the email analysis for follow-up questions and clarification. (For case descriptions see Table 1.) Ten months of fieldwork were completed to the stage of "theoretical saturation" (Glaser & Strauss, 1967: 65) where "no additional data are being found whereby the (researcher) can develop properties of the category. As he sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated."

Interviews. Interviews were a suitable method for examining knowledge processes and social systems present in the teams. The interview format followed a conversational style which aims at establishing a "partnership" in order to obtain as much rich information as possible (Weiss, 1994). This is best accomplished by avoiding interruptions or changing the conversation too much, as long as the discussion is within the boundaries of the phenomenon under investigation. Hence I adopted a semi-structured interview format. The length of the interviews ranged from 40 to 75 minutes and each was conducted on site, in or near the participant's office. The interviews included broad questions such as "describe the project you are working on." More specific questions were asked regarding the use of email, FtF meetings, how knowledge was shared and created; and how problems and mistakes were addressed. These semi-structured interviews allowed for exploration of unanticipated issues to gain a more complete understanding of the dynamics in

the team. Moreover, we assessed level of interdependence in various ways: by asking informants to what extent they relied on other's know-how coding email exchanges based on task interdependence.

With background information in terms of documents that described the overall project, I generally initiated the case study by interviewing the project manager to get an overview of the project, its members, overall goals, timeline etc. All members of the teams were interviewed several times both FtF in nearby conference rooms or in the participant's office. In conjunction with the data coding, follow-up interviews allowed us to detect interesting themes and insights that I could later probe deeper on and compare and contrast with other interviews (Trochim, 1989). The interviews in Sweden were conducted in Swedish. Since my native language is Swedish, this posed minimal validity issues in terms of translation into English. Each interview was recorded on a laptop using Microsoft Onenote ™ software. Recording interviews is a common technique in qualitative research and assures accuracy, avoids any potential loss of content, and allows the investigator to focus on the interview questions and responses rather than on note taking (Weiss, 1994).

Data Coding. The software allowed us to create flags and codes and highlight relevant and interesting quotes that I later could return to by a search function in the program. Each interview was listened to a second time to make sure no important codes were omitted. A threefold coding procedure including *open coding, axial coding* and *selective coding* was used to develop a grounded theory of TBKW (Miles & Huberman, 1994); scholars have used similar iterative coding procedures

to identify underlying theoretical dimensions in knowledge work (e.g. Anand, Gardner & Morris, 2007). Open coding is an initial process of identifying concepts and their properties as discovered in the data. The next step involved axial coding, sorting and refining the initial categories discovered in the data. The final step, selective coding, involved integrating and refining categories into a theory (Straus & Corbin, 1998).

Observation. In addition to interviews, five observations of team-based knowledge work were conducted in order to understand TBKW in action. Each meeting lasted between 60 and 120 minutes. Three teleconference meetings were also observed. This offered helpful insights into how these meetings were conducted, the structure of the meeting, the sound quality, level of participation, language used, signs of knowledge activities etc. While I did not observe all teams in action, the observations still provided helpful evidence on issues to further probe during interviews. Due to confidentiality issues, recording meetings was not possible, but detailed notes were taken during and after each team meeting. Moreover, I was able to observe the office layouts and observe numerous informal interactions among team members adding additional data.

Emails. Over 400 emails from all six project teams were used to explore the extent to which each of the three knowledge processes was adopted via email. Each email was copied and pasted into a Word document and content analyzed and coded based on length, frequency, type of language, length of email strings, indication of knowledge creation, and sharing of information such as FYI, updates, coordination, or level of task interdependence. Emails were also coded to indicate single- or

double loop processing (see Table 2). The strength of analyzing emails was that, when discrepancies arose, I simply forwarded the email to the person who drafted it asking for clarification. This further strengthened the validity of the coding and hence the analysis.

Analytic Strategy. I used the constant comparison method, where the working theory is constantly compared and contrasted with new additional findings (Trochim, 1989). This technique allows the researcher to check and recheck the working theory against new evidence. As long as the working theory could explain the inconsistency, it stayed the same and became more nuanced. In cases where the working theory could not explain the discrepancy, the theory was subsequently modified.

Construct validity suggests "establishing correct operational measures for the concepts being studied" (Yin, 2003: 34). Several steps were taken to improve data accuracy. Confidentiality to participants was assured along with a signed confidentiality agreement with each organization that participated. To improve construct validity, I relied on multiple informants for each event described, observations, and archival data to adopt a triangulation strategy (Mathison, 1988). Internal validity is a form of causal explanation, that is, to determine whether x causes y. This is particularly challenging in qualitative research given the reliance on inferences of events that many times cannot be directly observed and was strengthened by the constant comparison technique discussed above. External validity concerns the problem of whether the study's findings are generalizable beyond the cases under investigation; a method by which the researcher is "striving

to generalize a particular set of results to some broader theory" (Yin, 2003: 37). Scholars relying on a single case have been criticized for the poor generalizablity of their findings. However, our use of data from a variety of teams in the pharmaceutical, insurance, engineering, and consumer health industries strengthens the analytical generalization to establish external validity.

Findings

The data revealed a complex mix of FtF, phone and email use in team-based knowledge work that was partially driven by characteristics of the knowledge processes and partially by political processes. Media use was also influenced by individual desires to maintain control as well as power discrepancies among team members. Specific findings are outlined next.

Knowledge Sharing. Based on data from interviews, observation and analysis of emails, it was apparent that all projects engaged in a complex mix of interactions that could transfer from one mechanism to another. Knowledge could be shared via a series of email exchanges between two team members or among the team as a whole. At times it could be initiated by a simple update to build shared understanding about the current state of the project. A series of emails could also be triggered by a member raising a question and making a decision and asking for the team's approval or input. While email exchanges at times could be the only form of interaction, the knowledge sharing process could switch to a telephone conversation that would end in a FtF meeting. Conversely, a FtF conversation could generate additional ideas and be continued via a telephone conversation or a series of email

exchanges in a “dynamic knowledge sharing” process of switching between the three different interaction means in knowledge sharing.

The switch from one medium to the other is illustrated in one email exchange between Mary, the project manager in project “Greenlight” and Tim, the external copyrighter. Mary was developing a paper-based training manual. However, the low-resolution printout did not show as well as when looking at the screen on the device. Mary emailed Tim to try to develop pictures suitable for the training manual.

Initial message from Mary:

I know this is an odd question to ask a copywriter, but I'm not sure how to make the picture of the woman look better on the left (today's pic) vs. previous (or, make the picture on the right look worse - i.e., add some wrinkles to her!). I don't know Photoshop very well, but I was wondering if you could just doctor up this woman's pic for me?? Let me know - thanks!!

I'll have comments back to you shortly!!!

/Mary

Reply from Tim, the external consultant:

Hey Mary,

I could probably doctor the color (and give her some sallow tone), but I don't know about creating realistic-looking wrinkles. You might want to consider me an "emergency" option ;)

/Tim

Reply from Mary:

How about ERASING wrinkles? ie., smoothing them out?

Reply from Tim:

Took about an hour, but here's the enhanced image (left-side one is her smoothed out photo).

Cheers, t.

Reply from Mary:

Oh my god, you rock!!!! Question, though: why is the smoothed one so much darker? can you make them the same?

Reply from Tim:

Hey Mary,

Actually, didn't change the lighting... I think it's something to do with Photoshop, so ran auto-contrast to make them identical. I hope you were kidding about adding some lines back in your phone msg, as this was very tricky and I had to call a Photoshop expert for help. Anyhoo, here's the updated side-by-side comparison slide. I tried calling you at the office and must've missed you. I will be gone for some time this afternoon, so I guess we'll try & connect this evening?

Reply from Mary:

Nope, i'm here - i'll try calling you right now

The string of emails is illustrative in several ways. First, it illustrates the strength of the asynchronous interaction. Tim needed to develop the images during an hour. To meet FtF to discuss and then return to his office would have been inefficient. Second, it highlights the combination of knowledge sharing and knowledge creation. Mary has a question about enhancing the pictures (knowledge sharing) that Tim follows up on (knowledge creation). Third, it also highlights how in addition to email, Mary used telephone (voicemail) to clarify her questions. Finally, the entire email/voicemail interaction is then concluded via a synchronous telephone interaction.

This email exchange also illustrates the sequential interaction shift between email and telephone use, which supports the model outlined in Figure 1. At times, email exchanges would suffice, but as the issue grew in length and complexity, members tended to transition over to synchronous interaction and end the string of emails by stating “call me!” or “Stop! I’m coming up to you!” When probing informants about this tendency, many of the responses given suggested that bi-directional communication was a major factor. A key driver for switching media in the sharing process was the need to reach shared understanding without wasting time and effort.

Content analysis of emails suggested that email was primarily used for quick and short questions that left little room for misunderstanding. However, with more ambiguous tasks characterized by confusion or complexity, knowledge sharing via email appeared to break down quickly. Instead of moving the issue forward, members commonly engaged in more follow-up emails to clarify previous emails

that many times ended in a phone call or a FtF interaction. Table 2 depicts the content analyses of the emails used in each project based on length, frequency, type of language, length of email strings, use of attachments, use of knowledge processes.

Insert Table 2
About Here

While email was often viewed as a communication barrier, paradoxically, it was also used to enhance clarity in many instances given its rehearsibility and ability to turn tacit knowledge into codified explicit knowledge. This was based on the logic that redundancy of communication channels could assure better understanding. This was particularly the case in cross-functional teams. By leveraging multiple media, members from different functions could clarify and avoid future confusion by codifying meeting minutes or product technical specifications. Sten, the project manager for the Wheelbase project, explained this use of phone followed by email to codify knowledge:

> When I work with the purchaser or vendor, I use several ways to communicate including personal meeting, email and phone. Typically, when I talk to them over the phone, I write an email about what we decided to have it on paper and make sure we understand each other.

In sum, knowledge sharing occurred through all three media. The primary use of email was for short and simple knowledge exchanges that would leave little doubt that a shared understanding was reached. However, as knowledge became more complex, exchanges shifted towards synchronous interaction initiated primarily by phone but also FtF when physical proximity allowed.

Knowledge Creation. Knowledge creation, the central mechanism to move the project forward, occurred through a dynamic process as well. All three means were used for this activity but tended to differ depending on the level of knowledge interdependence. Some projects were relatively independent in the workflow, which left room for individual knowledge creation (i.e. project Wheelbase and project Start). These types of workflow fostered email use for coordination, action, and updates on individual tasks with limited social knowledge creation. Leif, a team member of the Start project, reflected:

> The project is fairly independent work. Each person works on their own and then re-checks with the team to see what they think, if they have any reactions or thoughts that can improve the individual deliverables. It's good in a way to work virtually. Sometimes it feels that all we do is to have meetings. Virtuality forces you to work and push forward since we have to divide up the work.

Other more complex projects where members had to rely on each other's knowledge necessitated a complex mix of both virtual and FtF interaction (e.g. projects Greenlight, E-letter). The need for constant interaction to integrate know-how in the work process created a combination of emails, telephone conversations and physical FtF meetings similar to the ongoing knowledge sharing process outlined above. As the team worked, the members realized that more knowledge was needed to make a decision which would trigger a mix of interaction mechanisms as John, one of the project members of the AOP project explained:

> When we addressed this complex issue it needed to be FtF to address the problem. We communicate much better FtF but we can't solve everything FtF. Sometimes when we sit in meetings and try to solve a problem we realize that we need more knowledge. We then typically follow-up with an email once we get the information we needed to make a decision.

The type of knowledge-creating process also produced differences in media use: exploitative knowledge creation tended to be addressed more asynchronously, whereas knowledge exploration tended to occur in more synchronous ways.

Exploitation. The exploitative nature of the tasks where minor improvements were addressed and implemented made email use an effective tool. Because much of the understanding needed to make a decision was there, it many times came down to an easy "yes-or-no" decision not requiring a lengthy discussion to consider a range of alternatives or factors. Jenn, a member of the Start project, explained:

> The way we choose to communicate depends on the concreteness of the question. If it's a yes-no decision, emails are fine. But often you need to explain yourself and the reason you are asking something so I tend to pick up the phone.

The need for explanation was closely linked with the nature of the task. That is, as the task required more thought processing, the interaction transformed from asynchronous to more synchronous interaction. Many times, an email could be a trigger for a question or a problem that would seem simple at first. After a series of emails, the complexity of the issue might surface revealing a more "exploratory problem", which would transform the nature of the interaction to a live conversation.

Exploration. Physical meetings were particularly essential when longer workshop modes (i.e. knowledge creation episodes) were necessary to map out the project and draw on each other's experience and expertise in a physical manner not possible via virtual means. Many sessions were explorative in nature and needed full engagement of all team members. Mary, a project manager, highlighted this in her reflection on the importance of working FtF in early stages of the OPT project:

> It's very difficult to brainstorm via email particularly when we developed the project framework, what I mean is that we tried to understand what the project would look like including key milestones, work processes, and individual responsibilities. We worked very much with post-it! Each function gets its own color. Everyone writes down everything they can think of that they need to do in this project on a post-it note. Each person then walks up to the board and posts them on the board in the sequence they think each task needs to be done so that everyone can see them This is very effective because when we try to figure out the order of things, others can comment… The PM could not know all of this…This gives us the visual order of tasks needed for the project...It also creates a togetherness, energy and personal commitment since we all know what you as an individual is responsible for.

The quote illustrates the importance of building on each other's tacit knowledge that would be difficult to recall and implement if the project map was built individually. That is, it illustrates the importance of the external memory banks of all team members (meta-memories) where a member's knowledge base can help trigger individual memory (i.e. knowledge) and add and help sharpen, in this instance, the project map. As Polanyi (1966) pointed out, we know more than we can tell; many times members did not know their entire area of responsibility and were assisted by the other team members. Moreover, the post-it mapping of the project also illustrates how tacit knowledge can be turned explicit by "coding" roles and responsibilities, and the general workflow of the project. Finally, the need for a visual view of the project map further lends evidence to the importance of physical interaction for creating complex knowledge.

In sum, asynchronous interaction was driven primarily by the nature of the interdependence and the type of knowledge creation process necessary. When projects were relatively less interdependent, work could be divided up and "social" knowledge creation was reduced and subsequently fostered a more email-based

team dynamic. Moreover, when teams needed to engage in more uncertain (i.e. explorative) knowledge creation, they opted to use more synchronous interaction where FtF was preferred.

Team Learning. The process of adjusting to solve and work around errors or unanticipated mistakes (i.e. team learning) varied depending on the magnitude of the error (i.e. single- or double-loop). Single-loop learning episodes, similar to exploitative knowledge creation, seemed to be solvable primarily virtually. As long as the mistake or obstacle did not interfere with the current project path, a series of emails tended to suffice. However, as the mistake grew in magnitude, more physical meetings tended to be necessary. Interestingly, the absence of physical interaction was to a large extent an explanation as to why mistakes and errors occurred.

> We had a mistake that really goes all the way from the very start of the project. The PDF forms that we are having the vendor print does [sic] not load into the project. We were finally able to solve it but I think we would have done this project again, we would have been able to anticipate it. IT and In-house [internal ad agency] should have been working closer. They never met physically and only interacted via email or occasional phone calls. We became a middle man and prevent[ed] them from working closely. At this point, they are working closely and it is working better.

To actually address double-loop learning, physical interaction appeared critical. The driving force for these physical meetings was the need to draw on multiple knowledge bases in conjunction with a clear understanding of the nature of the problem. Phone calls seemed too limited since they prevented full engagement.

In summary, the data indicates a complex mix of FTF, phone and email use to engage in knowledge processing. The media choice is driven by the nature of the knowledge processes and knowledge interdependence. That is, the reliance on others' know-how becomes a central mechanism that forces close collaboration in

form of more synchronous interaction. Moreover, the tacit nature of the knowledge being shared, exploratory and double-looping processing contributes to more synchronous media use.

Political Dynamics

The general virtual team literature suggests that media are used based on the complexity of the message being sent and the nature of the task, as outlined above. However, such rational factors were not the only motivators. Interesting political processes were observed as well which influenced personal decisions about which media to use for which purposes. The notion of "office politics" in the work place can be viewed as the informal governance in an organization; it is generally linked with a negative phenomenon when the informal operations run counter to the interests of the formal organization (Ferris, Frink, Galang, Zhou, Kacmar & Howard, 1996; also see review by Ferris, Adams, Kolodinsky, Hochwarter & Ammeter, 2002). Yet, it is worth pointing out that political dynamics may serve as a positive force when it works to support and improve the working of the formal system.

Strategic Ambiguity. One political theme that emerged during the fieldwork, and discussed in chapter 3, was the fact that members opted to use different media in different contexts, independent of the nature of the task or message. This phenomenon parallels Eisenberg's (1984) notion of strategic ambiguity. The central argument of strategic ambiguity is that individuals use ambiguous communication deliberately to accomplish their goals, which can promote "unified

diversity" (i.e. divergent perspectives with a shared common goal), facilitate change, and amplify and maintain power linked with a position.

Team members used strategic ambiguity in several ways that had implications for media use and knowledge sharing. While email could easily be used to respond to a question, members occasionally opted not to respond. This resistance to codifying certain knowledge was particularly prevalent when there were organized roles and responsibilities. While interactions may have started via a FtF meeting or a telephone conversation, many times a follow-up email was crafted re-stating agreed upon agenda items. Kathy, a marketing manager in the Start project, made this point clear:

> Email may be a dangerous tool to communicate since it can be used to show accountability. I save emails to show what I have done and what others have committed to do. Even if you discuss something over the phone, to document important issues I often asks [sic] for a summary in an email both to document the decision but also to know who said what later on. I often go back to these emails and save them in a special file. But emails are dangerous and I often think about what I write and don't write.

Joanne, a project member in the Greenlight project further elaborated on the strategic ambiguity:

> Some people don't get it or pretend they don't get it. Some don't care or ignore the email. When they don't answer the entire question, I have to pick up the phone. And I guess that's what they want me to do. It's a subtle point by changing from codified knowledge to non-documented knowledge. So when I know this is a sensitive issue instead of replying with another email, I tend to pick up the phone because I would never get an answer otherwise.

The two quotes above illustrate two important points. First, media are chosen at times based on the willingness and unwillingness to make knowledge explicit (i.e. codified). When asked why this was, members often replied that not wanting to be

held accountable later on or questioned later about contributions or added value to the team's effort were key factors for this apparent strategic ambiguity. Second, strategic ambiguity can occur by not choosing to reply via explicit means. By ignoring certain questions in an email, questions that may conflict with the receiver's priorities or interests, the respondent forces others to adopt other forms of interaction that do not result in explicit knowledge.

Sensitive information also played an important role in driving more synchronous media use. Turning to telephone and FtF interaction to avoid codification via email was a mechanism to maintain (rather than reduce) ambiguity. This was particularly so when performance problems with particular members were discussed, such as destructive or confrontational communication styles, missing deadlines or poor quality work. Avoiding discussion of sensitive topics via email was another form of strategic ambiguity. Keeping it "live" tended to work as a safety mechanism whereby the comments of others could not be traced to the individual but to the group as a whole.

While not as prevalent, it is interesting to note that email could also be used to maintain strategic ambiguity. Simply because the knowledge had been codified in form of an email did not necessarily mean that it was unambiguous. At times, when members had to reply to a concrete question, members would write emails that could be interpreted in several ways or not address all issues in the email. When probing informants on this issue, the explanation followed a similar logic to the choice of media – that emails allowed the responder to decide when and what to

specifically reply to. The respondent could simply ignore part of the question and in a sense maintain ambiguity. Joan, a team member from APO project reflected,

> It happens that people don't respond to the entire email. It's like they pick and choose what they feel like addressing. Of course, people make honest mistakes, but it's obvious sometimes that they don't want to answer a question. I just have to pick up the phone when this happens...People can also write confusing emails. Maybe they were in a hurry but sometimes you wonder?

Delaying a response could also help dilute the clarity of the message since the sender might have forgotten the context and background information for sending the email in the first place; which would introduce noise in the communication process. However, the timing of response or the silence by not responding was also linked with status differentials.

Status Differentials. Another key factor closely linked with strategic ambiguity was status differentials. Status, used here interchangeably with power, is the capacity that one individual has over another individual to impact his/her behavior in a desired way, and is a function of dependency (Pfeffer, 1992; Emerson, 1962). This dependency can be either structurally determined by an individual's position in the organization and team (i.e., project manager) or informally, based on the knowledge held by the individual. Kanter (1977) suggested that individuals display different behaviors (i.e., use of media) contingent upon whether certain structural supports (power and opportunity) are in place.

Consistent with Kanter's (1977) general theory, status differentials could be exhibited in different ways in the projects studied. For example, status influenced which political strategies were used: namely, lower level employees tended to

involve multiple team members as well as multiple media to counter the use of strategic ambiguity (which often occurred through lack of response or silence) by higher-level members. This was apparent when individuals mobilized other lower status members to "push" a higher status member to react. Not responding promptly was a mechanism to display and maintain status differentials. Michael, a team member on the Greenlight project, explained how this multi-source communication was used behind the scenes to move the project along:

> I must have Richard [VP of product development] send materials to the design agency since I won't be here, so now I have to make sure that Richard follows through since he doesn't always read email. So, I left him a VM [voice mail], and I will follow up with Mary [a project member] since I know that she is extremely responsive and will get it done. If she and Ken don't get something from Richard after some gentle prodding, which happens frequently… I've also CC'd my admin on the note so that she will know to push him [Richard] as well. As a last resort, I will call Richard myself to remind him if I don't here progress by next Wednesday night.

The quote illustrates the time pressure and the use of multiple people and different means to get things accomplished. Phone and voice mail are used here as additional interaction mechanisms to make sure information is passed along by the right person at the right time. Moreover, the quote suggests the challenge of getting access to and the attention of the senior people who may have different priorities.

The quote also illustrates the use of silence and the fact that status differences tended to influence of the degree of responsiveness. Not responding promptly was a significant way to display and maintain status differentials. When probing on this issue, it was evident that silence, rooted in status differentials, impacted the nature of the interaction and media. When members of similar status interacted, silence through lack of response to an email or voicemail triggered multiple reminders. The

person awaiting a response felt comfortable with sending multiple reminders. However, silence from a higher status member triggered a different response. Leveraging others in the project team was a common mechanism to help circumvent silence. It was interesting to note that members tended to use this strategy to avoid being perceived as overly aggressive or demanding. After all, status or power differences could impact the relationship and the subordinate's reputation negatively. As a result, subordinates faced the delicate challenge of advancing their ideas and needs while managing power differences carefully.

Another form of silence could be displayed by "shutting down" conversations. In cases where individuals brought ideas or suggestions, a higher status person could simply ignore them or stop the conversation by a single-sentence email, for example, "this is not a priority at the moment". This could also occur via more synchronous interactions in meetings or in teleconference. Thus, silence in this form was a strong indicator of exhibiting status differences that would have implications on how members interacted. Finally, status differentials impacted day-to-day interaction between team members. Email was often used to free up time for higher status members of the team. This tendency seemed rooted in the comfort level in using more informal media between colleagues and sending updates to superiors as explained by Jenny from the APO project:

> I speak more informally with people at the same level. You use emails to inform higher level - they get so many emails and phone calls, they can read the email when they have time and I don't want to bother them with silly questions.

Knowledge sharing tended to perpetuate status differentials as updates tended to flow upwards. This was mainly a result of trying to reduce the amount of action

needed by higher-level employees. It seemed that time was considered more valuable for those higher up in the hierarchy. However, both knowledge creation and team learning tended to reduce this tendency among team members. This was observed during several of the FtF team meetings across several projects. The need for synchronous interaction for complex knowledge processing forced the team to meet and address critical issues, generally putting their status differences aside and providing access to higher-level members participating in the meetings.

In summary, findings suggested that status influenced which political strategies were used: namely, lower level employees tended to involve multiple team members as well as multiple media to counter the use of strategic ambiguity (which often occurred through lack of response or silence) by higher-level members. Thus, strategic ambiguity then was both adopted and combated depending on the status of the team member. In other words, managers used strategic ambiguity more, while lower-level team members pushed for multi-channel communication to ensure responsiveness and/or clarity.

DISCUSSION

Drawing on a social shaping view of media use (Dutton, 1996; MacKenzie & Wajcman, 1985), the findings reveal the important roles played by both the nature of the knowledge processes and social factors in conducting team-based knowledge work. Taking a case-based research approach, the findings suggest that not only the knowledge interdependence and complexity of the knowledge processes but also the political relations of strategic ambiguity and status differentials influence how and when specific media are adopted. In light in these findings, we can begin to

flesh out a grounded theory as to when and how various media are used to conduct TBKW.

Evidence from the fieldwork indicates that team members used a complex mix of FtF, telephone, and email during knowledge sharing to reach shared understanding. The parties were involved in a dynamic interaction in which both the sender and receiver took on dual roles in the knowledge sharing process (Baskin & Bruno, 1977). Moreover, the nature of the task (i.e. interdependence) made it necessary to leverage multiple communication channels.

While this theory presented in Figure 1 appeared to hold up in most cases, political processes occasionally intervened and changed the predictions. That is, strategic ambiguity and status differentials appeared to work as two important mediators. At times, members opted for less efficient media; even if an email could be sent, members used other means to interact. The choice of media was in part influenced by individual interests to be strategically ambiguous (Eisenberg, 1984). The underlying logic for this strategic ambiguity is that members may have different or competing interests, goals, and personal agendas that contribute to the selection and use of media. Evidence from the interviews and emails suggested that, rather than trying to reduce equivocality as media richness theory would suggest, at times, individuals intentionally used FtF or phone conversations instead of drafting an email; while tacit knowledge is ambiguous by its very nature, once knowledge has been made explicit it becomes difficult or impossible for team members to ignore since it is written and generally stored and retrievable, which could have social consequences. That is, members did not reply via email simply because they

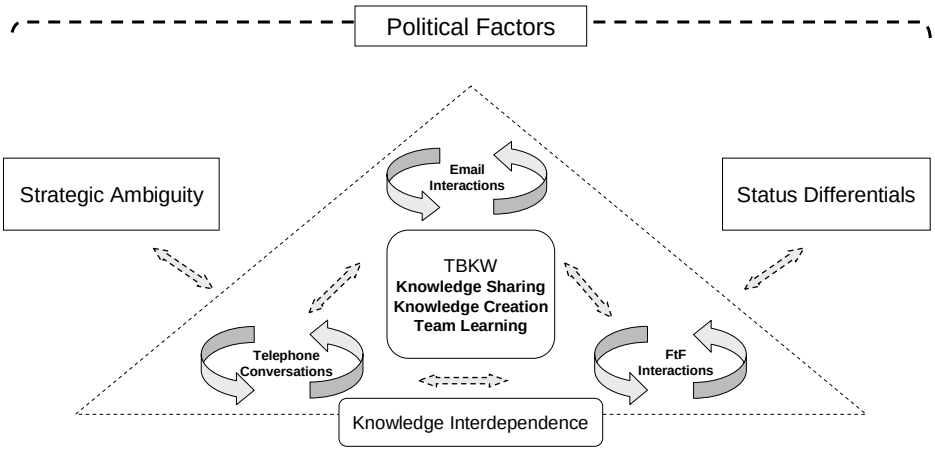
did not want to be explicit about their decisions or commitment or to be 'pinned down' later by being held accountable for a past decision. In a sense, avoiding emails that made agreements explicit provided more room for individual maneuvering and negotiations about subsequent expectations and agreements. Moreover, email allowed for more ambiguity as well given its asynchronous nature, lack of instant feedback, and lack of nonverbal cues which could betray true feelings or intentions and left less room for projection and interpretation.

Another political process that emerged in the fieldwork was due to status differentials. The fact that teams were composed of members of different status contributed to how members interacted. Lower-status team members tended to adopt strategies to get access to higher status members by leveraging multiple media as well as multiple actors. In contrast to knowledge sharing, the multiple channels adopted did not seem driven by the need for understanding but rather by the need for visibility and to ensure these members executed and followed up on essential issues. In other words, team members may have understood that certain things needed to be done, yet they did not prioritize to meet the most immediate goals. This made it time-consuming and challenging to mobilize momentum by aligning co-workers and suitable messages and timing this mobilization to push senior team members to accomplish goals.

While knowledge processes and the media choice seem driven by the desire to be efficient, the political processes explored in this study may in fact override such rational logic in media use. Figure 2 outlines the general relationship between the three knowledge processes, knowledge interdependence and different types of

media used to conduct knowledge work in the triangle. However, political factors are highlighted indicating that they at times may undermine the effectiveness model. That is, while the media richness theory predicts use of media to enhance clarity and efficiency, political factors rooted in strategic ambiguity and status differentials seem to undermine and even contradict this logic. Thus, in order to understand the dynamics of TBKW careful consideration must be taken of the complexity of the knowledge processes, nature of the interdependence as well as the underlying political issues, as they all can impact how interaction channels are leveraged.

Figure 2
Impacts of Political Factors on
Team-Based Knowledge Work



The findings offer several practical implications important to address as well. First, while practitioners seemed to spend more time executing, considering how

knowledge processes are conducted is important for reducing time and energy. At times, work can easily be carried out virtually, for example by teleconferences for updating meetings; however, as it becomes more complex, involving tacit knowledge, explorative knowledge creation and double-loop processing, teams must leverage more synchronous interaction mechanisms. These complex knowledge processes at times even make telephone discussions impossible given the challenges of transmitting nonverbal cues such as looks, sighs and expressions – all of which could indicate understanding or confusion. Second, senior members with higher status in the project that are not sensitive to status differentials in the team are likely to create excessive political maneuvering and waste of resources. Third, strategic ambiguity impacts how work is actually carried out in teams. Formal norms and policies might be adopted to prevent these patterns from reoccurring and may help reduce time and energy spent in reaching understanding.

A limitation important to address here, and not unique to this study, is the challenge of collecting data from a large enough sample size to ensure the findings are generalizable. While the primary purpose of adopting a qualitative research approach is to shed light on complex phenomena not conducive to quantitative approach, the findings must be interpreted with caution. However, the limited cases used here represent a range of different industries and provide initial understanding as to the complex mix of media use in TKBW. Another limitation worth pointing out and not addressed in this study, is the fact that variations in project size, leadership, task, knowledge, geographical dispersion of the team and so forth may

impact the nature of the interaction in the team. These factors have been found to impact team effectiveness and are likely to explain dynamics in TBKW as well.

This study offers a unique contribution to the emerging knowledge work and virtual teams fields. First, it offers insight to the general team literature regarding the proverbial black box of the *process* of knowledge work that is still largely unexplored and disorganized. Second, by transcending the traditional "either-or" perspective in the extant virtual team literature, the theory offered here contributes to our understanding of the complex fusion of different media to leverage knowledge in teams as well as pinpointing political elements involved in TBKW. While these findings are informative and add to the emerging virtual teams literature concerned with knowledge work, I have only begun to understand how the intricate merger between multiple media plays out in the workplace. It is our hope that this paper sheds light on the importance of leveraging knowledge for companies that compete based on knowledge. Moreover, it is also our hope that this study will help scholars to sharpen and advance additional research questions to further advance our understanding about this important topic, as knowledge is clearly becoming a critical resource for companies to compete on.

Table 1.
Description of Case Data

Case/ Characteristics	Greenlight	E-Letter	APO	Start	Power Box	Wheelbase
Objective	Build, design and launch a novel, stand alone medial device to assess facial skin condition/damage	Develop a new generic insurance letter to fit all existing polices and clients	Development of web-based service. Involved turning insurance products from paper to internet	Develop a new insurance policy tailored for a young customer base	Develop an multi-function electronic utility box for industrial use	Designing a safety feature for industrial use of a sliding mechanism of a suction device for exhaust
Case description	Complex novel problem involving a wide range of stakeholders.	A novel project complicated by the many format requirements, printing issues, content, making it highly complex task	Clear objective but without existing processes to address the needed change	A well defined objective based on an existing one from Norway	A well defined problem, standard processes, clear roles and responsibilities	A well defined problem, standard processes, clear roles and responsibilities
Core Membership Representation	Marketing, IT, Engineering, Manufacturing, Finance	Product development, Sales	IT, Internet, Marketing	Product development, Marketing, Internet, IT, Sales, Training,	Engineering, Sales, Manufacturing, Knowledge integration	Engineering, Sales, Manufacturing, Knowledge integration
Level of interdependences among members	High	High	High	Low	Medium/Low	Low
Location	USA	Sweden	Sweden	Sweden	Sweden	Sweden
Percent of team members interviewed	83	100	83	100	100	100
Size	12	4	6	7	5	5
Time frame	2 year	9 months	8 months	6 months	8 months	9 months

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Table 2.
Use of Email across Projects

Email Characteristics /Project	Greenlight	E-Letter	APO	Start	Power Box	Wheelbase
Length e.g. # lines, # issues, # questions per email	Long	Medium	Medium/Long	Short	Short	Short
Frequency e.g. # emails per day (very high, high, medium, low)	Very high	High	High	Medium	Low	Low
Type of language e.g. formal vs. informal	Mixed. The longer the string the less formal the language.	Mixed. The longer the string the less formal the language.	Mixed. Very informal between the IT members.	Typically formal, copied among all team members.	Formal	Formal
Length of email strings e.g. # of replies or exchanges per issue	Long (10-15 messages per topic)	Medium	Medium (mixed long and short)	Medium (5-6 email exchanges)	Short	Short/Medium
Attachments e.g. tendency to attach documents / files	High (team charter attached initially)	High (team charter central for updating members)	Low (process model of new web-based insurance system not easily shared via email)	High (team charter key for ongoing updates and building alignment)	Low (team charter used, but few attachments)	Low (exchanged btw/ engineer and project mgr. on an FYI basis)
Knowledge sharing e.g. coordination/update, sharing, building understanding etc.	High	High	High	High	Low	Low
Knowledge creation e.g. exploitative = small improvements explorative= new larger improvements	High on both exploitative and explorative	High exploitative Low explorative	Medium exploitative Low explorative	High exploitative Low explorative	Low	Low

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Team Learning e.g. single-loop = small errors, double-loop = significant changes	Small errors via email, larger errors by FtF or phone	Medium single-loop, double-loop confined to workshops	Medium single-loop, no double-loop via email	Low. Single-loop occasional, via email	Low.	Low/Medium. Minor challenges addressed before significant

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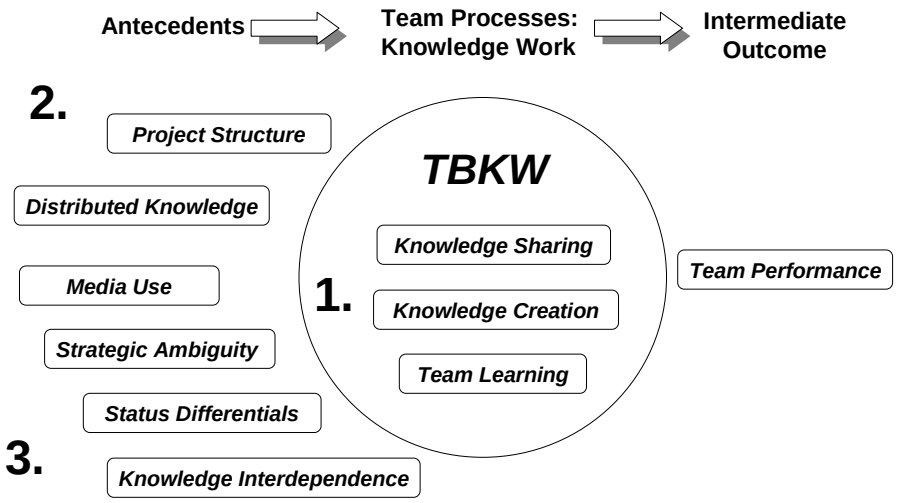
CHAPTER 5

CONCLUSION: AN INTEGRATION OF THREE ESSAYS

The purpose of this dissertation was threefold. In the first essay, I explored and fleshed out the proverbial black box of team-based knowledge work (TBKW) by identifying and linking three key knowledge *processes* – knowledge sharing, knowledge creation and team learning. In the second essay, I linked these processes with the structure of the task and the distributed knowledge necessary to carry out the task by developing a 2x2 framework of understanding four different types of TBKW. Next, in essay 3, I delved deeper into the dynamics in TBKW by exploring the use of different media and political dynamics involved in mobilizing knowledge in TBKW. The purpose in this final chapter is to merge all three essays outlined in Figure 1 below. It is an attempt to link various concepts and theories discussed throughout the three essays with the aim of providing more clarity as to the overall synthesis of this dissertation.

Figure 1
Comprehensive Research Model:
Dynamics in Team-Based Knowledge Work (TBKW)



The chapter is organized by first discussing each of the four ideal types of TBKW and the media used by highlighting two conceptually different yet related theories – transactive memory theory and media richness theory. Next, I consider media use and political dynamics and then link them with types of TBKW. Finally, I summarize the overall conclusions reached in the dissertation.

Problem Structure, Distributed Knowledge and Media use. Project teams are assembled to address a problem. This problem can vary in terms of clarity, referred to here as the structure of the problem, which plays a key role in shaping the nature of the work and was discussed in-depth in essay 2. Briefly, ill-structured problems can be characterized as having unclear objectives, non-existent processes and routines in place, and unclear or uncertain know-how to handle a particular problem. Conversely, well-structured problems have a clear objective where processes, routines, and know-how exist and are readily available for the task at hand. A second factor that appeared

to shape the nature of TBKW was distributed knowledge, that is, the nature of knowledge needed for the project. Some projects could address the problem with more homogenous knowledge existing in a single function while others required more distributed knowledge, where the makeup of the team was cross-functional. Accordingly, I offered four types of TBKW – Standardized, Modular, Emerging and Collaborative TBKW – and placed each type in a 2x2 framework depicted in Figure 2.

Figure 2

Four Ideal Forms of TBKW: Structural Problems and Distributed Knowledge

Nature of the Problem

Distributed Knowledge	*Ill-Structured*	*Well-Structured*
High	**Collaborative TBKW** Collaborative T Requires extensive reciprocal interaction in a non-hierarchical fashion for effective knowledge sharing, knowledge creation, and exhibits frequent single- and double-loop processing.	**Modular TBKW** Modular TBKW is conducted through predefined discrete steps handled by specified experts, working in a modular fashion through a pooled interdependence.
Low	**Emerging TBKW** Best conducted through alternations of individual problem-solving and group review/ brainstorming (moderate reciprocal interdependence).	**Standardized TBKW** Standardized TBKW is handled by individual experts in a bureaucratic work structure (sequential interdependence) where knowledge sharing, knowledge creation and team learning is limited.

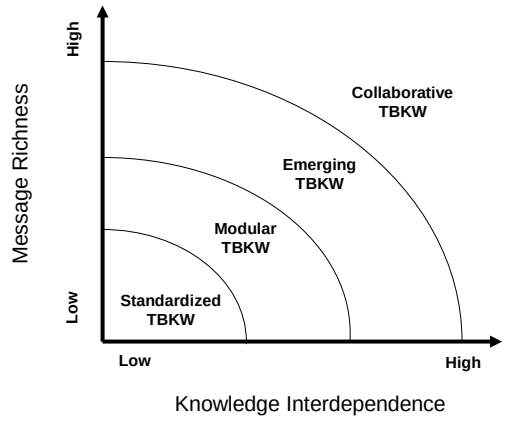
Both the structure of the problem and the knowledge needed may have important implications as to when and how different media are used and can be placed in a theoretical framework drawing on two distinct but related theories: the transactive memory theory (Wegner, 1989) and media richness theory (Daft & Lengel, 1984) outlined in essay three. The former emphasizes the degree of knowledge interdependence and the latter stresses the richness of the message. Though these theories may be viewed as competing and generally treated separately, both the knowledge and the nature of the message are intrinsically linked. Transactive memory theory suggests that interdependence among members to locate and recall essential knowledge for the task at hand is what drives effective teams. In other words, members both leverage their own internal memory banks but also rely on others' (external) "meta-memory banks" to mobilize knowledge in TBKW. The theory postulates that as individuals need to rely more on others' memories, as would be expected in more complex knowledge processing, more synchronous interaction will occur.

Yet, while the nature of the interdependence is important to understand dynamics in TBKW, essay two stops short in considering the importance of media use – the vehicle to mobilize knowledge. The general assumption in the virtual team literature is that virtual teams (VT) are used when a broad set of knowledge is necessary for the task at hand that is not proximally available. That is, the range of knowledge needed would drive more asynchronous media use. However, what also impacts the use of media is the nature of the messages, which is generally rooted in the media richness theory (Daft & Lengel, 1984). Daft and Lengel's media richness theory (MRT) makes

two assumptions. First, individuals process information to reduce uncertainty and equivocality. Second, certain media work better for particular tasks than others. Email is more suitable for unequivocal messages while FTF would work better for equivocal messages. The logic is that as the richness of the information increases, individuals would adopt a media that allows for more instant feedback (i.e. synchronous).

While the transactive memory theory suggests that knowledge interdependence drives the use of more "live" interactions, MRT suggests that it is the richness of the message that fosters more synchronous media use as outlined in Figure 3. The vertical axis indicates the nature of the knowledge processing, were high indicates very rich processing involving tacit, exploratory and double looping activities. The horizontal axis indicates the nature of the interdependence needed to conduct knowledge work. If we apply both theories among types of TBKW, on the one extreme, standardized TBKW require a minimum amount of interactions as well as emphasis on independent work. On the other extreme, collaborative TBKW involves frequent interaction and highly interdependent work.

Figure 3
Media Richness and Knowledge Interdependence in TBKW



The central argument here is that knowledge interdependence and message richness cannot be disentangled, both are linked with the nature of the work. As the task at hand requires more interdependent work it turns increasingly challenging to mobilize both individual and team memories. The challenge is to articulate the tacit know-how which requires continues dialogs in form of instant feedback, non-verbal cues to reach full understanding and access to the "meta-memory" of the team. As members have to rely on others memories (greater interdependence), the richness of the message being exchanged increases as well. This relationship between knowledge interdependence and message richness is outlined in Figure 3.

We can apply this logic to types of TBKW. By its very definition, collaborative TKBW (Greenlight project) involved more complex knowledge processing. That is, the need for sharing tacit knowledge and engaging in more exploratory knowledge and double-loop processing requires more interdependent thinking and renders

asynchronous media less suitable for these activities. Collaborative (Greenlight project), and to some extent Emerging TBKW (E-Letter), generally had a significantly higher need for interactions – not surprising given the complexity of the work. However, it is worth noting that these projects involved addressing simple questions, straight forward coordination, and simple tasks at times that were easily handled by emails. Both projexts engaged in heavy email use for simple knowledge processing but more phone calls and FtF meetings were used to handle complex knowledge processing. An informant from the Greenlight project referred to his company as having an "email culture", suggesting that the way things are done here is primarily via email but when required, which was frequent, more live conversations were adopted. In contrast, both the Start project (Modular TBKW) and the Wheelbase project (Standardized TBKW) was characterized by less frequent interaction. However, when interactions occurred, email use seemed like a sufficient media since complex knowledge processing were kept at a minimum.

Political Dynamics

The general virtual team literature suggests that media are used based on the complexity of the message being sent and the nature of the task, as outlined above. Yet, such rational factors were not the only motivators. Interesting political processes were observed as well which influenced personal decisions about which media to use for which purposes.

Individual Strategic Ambiguity. One political theme that emerged during the fieldwork, and discussed in essay 3, was the fact that members opted to use different media in different contexts, independent of the nature of the task or message. This

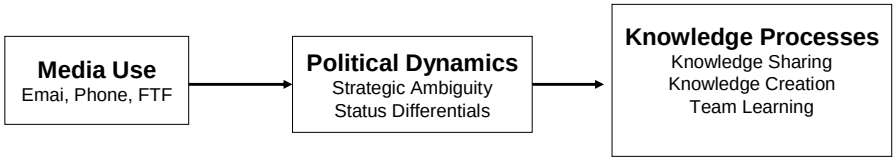
phenomenon parallels Eisenberg's (1984) notion of strategic ambiguity (not to be confused with organizational strategy). In short, the central argument of strategic ambiguity is that individuals use ambiguous communication deliberately to accomplish their goals. Important to point out is that Eisenberg did not view strategic ambiguity is as a negative phenomenon, in fact, to the contrary, it could actually generate added value in the proper context. He argued that strategic ambiguity can promote "unified diversity" (i.e. divergent perspectives with a shared common goal), facilitate change, and amplify and maintain power linked with a position.

One method to maintain strategic ambiguity observed in the cases was to avoid interaction via email. The logic was the "codificability" of email made team members reluctant to respond since they could later be held accountable and pinned down based on the permanent record of the email. While not as prevalent, it was interesting to note that email could also be used to maintain strategic ambiguity, which seems to raise doubts about the assumption of MRT and the desire to reduce uncertainty and equivocality. Simply because the knowledge had been codified in the form of an email did not necessarily mean that it was unambiguous. At times, when members had to reply to a concrete question, they would write emails that could be interpreted in several ways or not address all issues in the email.

Status Differentials. Another key factor closely linked with strategic ambiguity was status differentials. Status influenced which political strategies were used: namely, lower level employees tended to involve multiple team members as well as multiple media to counter the use of strategic ambiguity (which often occurred through lack of response or silence) by higher-level members. This was apparent

when individuals mobilized other lower status members to "push" a higher status member to react. Not responding promptly was a mechanism to display and maintain status differentials. It was evident that silence, rooted in status differentials, impacted the nature of the interaction and media. When members of similar status interacted, silence through lack of response to an email or voicemail triggered multiple reminders. However, higher status members adopted more strategic ambiguity behaviors simply because they were in a position to do so. Thus, linking status differentials, members adopted as well as combated strategic ambiguity depending on the status of the team member. Managers used strategic ambiguity as a tool, while lower-level team members pushed for multi-channel communication to ensure responsiveness and/or clarity. The mediating role of strategic ambiguity and status differentials is depicted in Figure 4.

Figure 4
Political Dynamics: Mediating Role of Strategic Ambiguity and Status Differentials

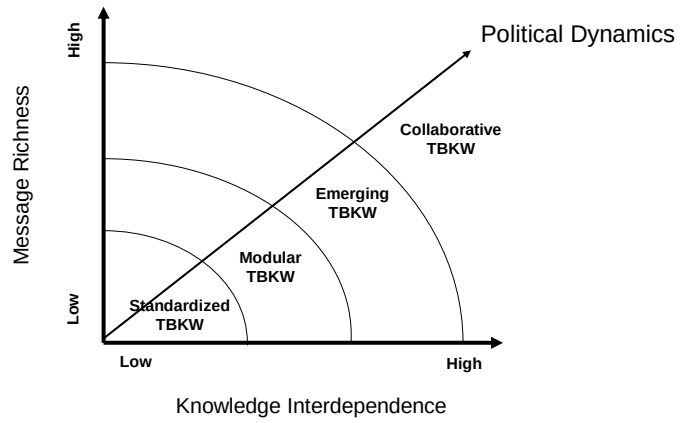


Knowledge sharing perpetuated status differentials as updates tended to flow upwards. This was mainly a result of trying to reduce the amount of action needed by higher-level employees. It seemed that time was considered more valuable for those higher up in the hierarchy. However, as the knowledge processes turned more complex, status differentials appeared to be reduced. That is, it would seem that more critical exploratory and double-looping episodes triggered more involvement from higher status members. The need for synchronous interaction for complex knowledge processing forced the team to meet and address critical issues, generally putting their status differences aside and providing access to higher-level members participating in the meetings. Hence, criticality of the knowledge processing activity functioned as a status reduction mechanism. This pattern parallels other studies on high action oriented teams where lower level employees are allowed to be in charge, yet, in critical situations, higher status individuals would become involved (Klein, Ziegert, Knight, Xiao, in press).

Political Dynamics and Types of TKBW. There is a consistent view among scholars concerned with office politics that political behaviors are linked with complex and uncertain and ambiguous work environments (Ferris & Kacmar, 1992; Ferris, Frink, Galang, Zhou, Kacmar & Howard, 1996; also see review by Ferris, Adams, Kolodinsky, Hochwarter & Ammeter, 2002). Lack of clarity, roles and responsibilities and overall goals of the project can create excessive politicking. In line with the general political literature, political dynamics seemed to be linked with the complexity of the structure of the task faced by the team. The fieldwork suggested

that political dynamics played a differential impact in the four types of TBKW as outlined in Figure 5.

Figure 5
Linking Media Richness, Knowledge Interdependence, Types of TBKW and Political Dynamics



In a general sense, Standardized TBKW would be the most bureaucratic on the one extreme and Collaborative TBKW the least bureaucratic on the other extreme. Well-structured projects (Wheelbase and Start), appeared to experience less political dynamics since responsibilities were generally clear. The underlying rational for this pattern could be attributed to the nature of knowledge work as it is conducted on the edge of what is known. The uncertain ill-structured work suggests that even the senior manager did not know all the necessary steps, knowledge etc to make the project a success. By being ambiguous, the senior manager avoided of making decisions that could later turn out to be less than optimal or even incorrect and perhaps lose credibility and status. In contrast, the lower standing team members pushed for clarity and clear directions and as such being strategically non-ambiguous.

In sum, it is important to note the relationship of political dynamics in the 2x2 contingency framework outlined in essay 2. First, ill-structured work requires more collaboration, especially when members are pulled from different functions. In turn, as the ill-structured task requires more teamwork (i.e. interdependence), it seemed to spur more political dynamics. While I did not explore the benefits and challenges with political dynamics, what appears important for practitioners to acknowledge are not to ignore and push the informal political issues underground by formal directs and threats. Office politics can in fact add value when it works to support and improve the working of the formal system that is team-based knowledge work.

Final Thoughts. In the three essays that compose this dissertation, I have wrestled with abstract and complex issues involved in TBKW. I set out to explore the black box of the processes of knowledge work – knowledge sharing, knowledge creation and team learning, the foundational elements of TBKW. As I gained more clarity about the underlying key knowledge processes in a traditional qualitative fashion, I expanded my focus to understand structural factors that were essential to place these knowledge processes in context. The main conclusion was that not all types of TBKW required teamwork in a traditional sense. Contingent upon the problem and knowledge, teamwork is a conditional work structure, not a given one, even in contemporary organizations. Next, I further widened the lens and considered media use and political dynamics in TBKW. The central findings suggested that not only is the nature of the knowledge being shared or created an important determinant of the media used to pursue the team's overall goal, but that political dynamics play a key mediating role in understanding when and how media is used to mobilize

knowledge. Political dynamics was further accentuated during interactions between members of unequal status.

In sum, as I have continued to explore the notion of TBKW, it is apparent that I have only yet begun to shed light on a critical topic that many managers are wrestling with. It would be presumptuous to suggest that I have provided a complete picture of the challenge of mobilizing knowledge in teams. However, it is my hope that these essays presented above would at least have blazed some new trails that can guide future work to better understand complex life in knowledge driven organizations.

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CURRICULUM VITA

Niclas L. Erhardt

Education

Rutgers University — Piscataway, NJ
Ph.D. School of Management and Labor Relations, Human Resource Management. — October, 2008

Rutgers University — Piscataway, NJ
M.S. Industrial and Labor Relations — 2005

Iowa State University — Ames, IA
M.S. Industrial Relations — 2001

Cornell University — Ithaca, NY
B.S. School of Industrial and Labor Relations, Industrial and Labor Relations — 1999

Danderyds Gymnasium — Danderyd, Sweden
High-School Degree in Business and Economics — 1993

Publications

Martin-Rios, C. & Erhardt, N. (Forthcoming). Organizational knowledge transfer through human resource management: International diffusion of managerial performance management. *European Journal of International Management*. Special Issue on "Global Performance Management in the European Context" D. Briscoe & L. Claus (Eds.)

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