Part II

Emerging Issues in Knowledge and Innovation

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Interactive Innovation Processes and the Problems of Managing Knowledge

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1. Introduction

In the early days of knowledge management both the literature and practice were relatively simplistic in orientation. Knowledge was seen as crucial in securing competitive advantage for *all* organizations and, consequently, organizations were encouraged to develop systems (often IT-based) in order to better manage their knowledge. Knowledge was typically treated as a resource, no different from any other organizational resource, such as land, labour or capital. Implicit in these approaches was the view that knowledge was a thing, or entity, located in people's heads that could, and should, be extracted, stored and circulated. Over time, however, there has been growing recognition in much of the organizational literature that this 'entitative', cognitive view of knowledge may be limited (Hosking and Morley, 1991). Recognizing these limitations, significantly more attention has been paid to conceptual developments around situated or processual views of knowledge and learning (Newell et al., 2002; Tsoukas and Vladimirou, 2001; Brown and Duguid, 2001). According to such views, knowledge is inseparable from social relationships and practice. Attention in the knowledge management literature has shifted towards addressing the organization of such relationships and practices (for example through the mobilization of social networks and 'communities of practice' – Brown and Duguid, 2001). It has also been argued that theory needs to be more sensitive to the links between knowledge management and the purposes (for example, tasks and activities) to which knowledge is being put (Hansen, 1999). For example, it has been argued that, while IT systems may support exploitation (that is, the re-use of existing knowledge and information), they are unlikely to facilitate exploration (that is, the creation of new knowledge and action – Swan et al., 2002). In this chapter we will explore, in particular, the implications for managing knowledge where the purpose is innovation.

The remainder of the chapter is structured as follows. First we outline the perspective on knowledge that we are adopting and relate this to innovation

processes. Recognizing that innovation has itself been studied from a number of different perspectives, we briefly outline three different perspectives (Slappendel, 1996). In particular, we argue that innovation is best understood, not as the transfer of knowledge and physical artifacts, but as a highly *interactive process* entailing combinations and flows of knowledge among social groups and organizations seeking to develop new practices (McLoughlin, 1999; Massey et al., 1998). We then explore in more detail the nature of interactivity in innovation processes and, through empirical examples drawn from our own research over the past five years, we consider the knowledge management challenges and issues related to interactive innovation. Specifically, we focus in our analysis on the implications of different kinds of interactivity for the ways in which knowledge is created and diffused, including: interactivity between structure and agency; interactivity between different stakeholder groups and organizations; and interactivity across different episodes of the innovation process (for example, exploration and exploitation). In the light of this analysis, the final section draws some conclusions about future knowledge management theory and practice.

2. Perspectives on knowledge

In developing our analysis we view knowledge as an integral aspect of the overall activity system of the organization (Blackler, 1995). Knowledge is not then a 'resource' that can simply be transferred (Barney, 1991); nor is it 'embedded' in organizational processes (Winter, 1987). Rather, from this perspective, knowledge is seen to emerge as people interact recurrently in the context of established (and novel) routines and procedures. Therefore, when firm members participate in organizational activities or practices, they have the potential simultaneously to create and extend the firm's knowledge (Spender, 1996; Carlile, 2002). This implies a social constructivist view of knowledge, whereby all human knowledge is developed, transmitted and maintained in social situations (Berger and Luckmann, 1966; Tsoukas and Vladimirou, 2001).

Looking more specifically at the relationship between knowledge and practice, both Nelson (1991) and Tsoukas (1996) view firms as hierarchies of routines, where most organizational knowledge is tacit and resides, not as isolated from context in the heads of individuals, but as situated in organized contexts of action. Thus, Tsoukas and Vladimirou define knowledge as 'the capability to draw distinctions, within a domain of action, based on an appreciation of context or theory, or both' (2001, p. 979). This definition highlights that knowledge is essentially related to human action (Nonaka and Takeuchi, 1995). However, in organizational settings, human action draws upon the generic rules and routines produced by the organization, hence knowledge is essentially tied to context. Moreover, each individual has only a partial view of what constitutes a particular organiza-

tional routine or practice or of the knowledge needed to design a new product or process. In other words, knowledge in organizations is distributed across social groups and communities engaged in different activities and practices – 'cognition, observed in everyday practice is distributed – stretched over, not divided among – mind, body, activity and culturally organized settings' (Lave and Wenger, 1991). It also needs to be acknowledged here that knowledge and learning are embedded in relationships of power and so will naturally be contested within and across communities of practice (Contu and Willmott, 2003). For these reasons, a central problem emerging during innovation is that knowledge generated in one domain does not transfer easily to another domain (Carlile, 2002).

For example, there are numerous 'breakthroughs' in scientific and technological knowledge that could drastically change medical practice. However, even where safety and effectiveness is validated (for example, through clinical trials), many such breakthroughs fail to be adopted by medical practitioners (Hilton et al., 2002). Often this is because they do not align well with existing, and highly institutionalized, professional and medical practices (Christensen et al., 2000). This means that the exploitation of scientific knowledge may require radical shifts in practices and relationships among different stakeholder groups (for example, different medical professionals, industrial scientists, academic scientists, managers, and so on). In some cases, entrenched power relationships make such shifts impossible (Hilton et al., 2002).

Innovation relies, therefore, not simply on the availability of new knowledge, but also on the ability to *integrate* knowledge across an increasingly distributed array of professional groups and organizations (Powell et al, 1996, Owen-Smith et al., 2002). As opposed to 'knowledge sharing' (that is, where groups come to appreciate and share one another's perspectives – Grant, 1996), knowledge integration emphasizes the combination and deployment of knowledge drawn from different domains in order to achieve specific innovation outcomes (for example, the development of a new product or process). This concept builds on, and extends, Okhuysen and Eisenhardt's (2002) definition of knowledge integration as a process, whereby individuals combine their information to create new knowledge. Having established our perspective on knowledge and the important role of knowledge integration in many innovations, we next consider perspectives on innovation before highlighting the challenges posed by innovation for creating and diffusing knowledge.

3. Perspectives on innovation

Innovation is used variously in the literature to describe not only both the entity or object which is new (for example, a new artifact, product or process), but also the process by which the entity is created, developed or

diffused. Here we adopt the latter approach, and characterize innovation in broad processual terms as encompassing overlapping episodes of design, diffusion and implementation (Robertson et al., 1996; Alter and Hage, 1993; Clark and Staunton, 1989). Organizations appear to be more or less successful in relation to these innovation episodes, so that an organization's ability to innovate could be described as an organizational 'capability' (Zollo and Winter, 2002). At the heart of this, innovation capability is the ability to share, integrate and create knowledge within and across organizations (Spender, 1996; Grant, 1996). It follows, then, that innovation depends crucially on managing knowledge and situated learning (Lave and Wenger, 1991).

Among existing scholars that have chosen to characterize innovation in processual terms, it is also evident that very different perspectives on this process have been adopted. Slappendel's (1996) review of the innovation literature concludes that there are three major perspectives on the innovation process – the individualist, the structuralist and the interactive. These different perspectives, she argues, reflect the historical evolution of our understanding of innovation processes, with individualist perspectives being dominant in early accounts and interactive perspectives emerging more recently. Relating these to knowledge, we argue that each perspective adopts somewhat different assumptions about the nature of knowledge and knowledge management.

The individualist perspective

The individualist perspective assumes that innovation occurs through individuals making rational decisions about actions leading to specific outcomes. The focus is, therefore, on identifying characteristics of individuals that make them more likely to be innovative, for example their personality, their level of education and their cognitive style (see Rogers, 1995). This perspective places the locus of innovation at the level of the individual: the most crucial determinant of innovation is the knowledge and expertise held by the individual. Many new products, such as the bagless Dyson vacuum cleaner, associated with inventor James Dyson, are thus seen to originate from one person's genius or entrepreneurial activity and there is considerable interest in the innovation literature on the role of individual champions (Brown et al., 2004) as key determinants of successful innovation.

In relation to organizational innovation, this perspective is somewhat limited because it is apparent that within an organization there are likely to be multiple participants involved in innovation. Nevertheless, the perspective can be broadened to encompass the idea that innovation depends on the knowledge of multiple individuals who pool this knowledge to make decisions. Some of the literature also recognizes the limits to the cognitive capacities of actors (March and Simon, 1958) and so does not assume that individuals will always act rationally, that is, in their best interests.

Essentially, this amendment importantly suggests that a lack of full knowledge as possessed by an individual or group of individuals can limit or distort innovation processes.

Table 6.1 depicts the view of knowledge that underpins this individualist perspective on innovation. Thus knowledge is seen as largely embrained in the tacit understandings and cognitive processes of individual actors. The implications of such a view for managing knowledge are that these tacit understandings need to be shared and mobilized into action. This might be achieved through codification strategies (aimed at making the tacit knowledge of individuals explicit) or at personalization strategies (aimed at sharing tacit understandings through interpersonal interaction and social networks – Hansen, 1999). While there are many criticisms of this approach (see Slappendel, 1996 for a review), one of its key limitations is that it

Table 6.1 **Views of knowledge from different innovation perspectives**

	Individualist	**Structuralist**	**Interactive Process**
View of Knowledge	Embrained knowledge – in the heads of individuals	Embedded knowledge – in systems and structures	Situated knowledge sustained through and in processes of interaction among people in particular contexts
Strategy for managing knowledge	Personalization and codification	Codification	Shared practice
Mode of knowledge sharing	Through connecting individuals and/or making tacit knowledge explicit	Through organizational designs and systems, including links with other organizations	Through interactive networking, joint tasks and the formation of shared values and identities.
Knowledge stability	Knowledge stable and rationale leading to one conclusion	Knowledge stable and leading to one conclusion	Knowledge emergent from process and equivocal
Knowledge and decision-making	Individuals actively using personal knowledge to make decisions	Individuals passively responding to external influences	Individuals actively involved in the construction of the knowledge base, albeit constrained by the institutional context

privileges individual agency over structure, so ignoring (or at least de-emphasizing) the ways in which individual actors are constrained in their thoughts, behaviours and emotions by the contexts in which they exist, including group, organizational and broader institutional structures.

The structuralist perspective

This perspective on innovation has attempted to redress the limitations of the individualist perspectives by highlighting the ways in which innovation is promoted or constrained by structural characteristics of organizations, themselves embedded in wider institutional arrangements. Thus scholars have sought to establish causal relationships between structural characteristics of organizations and innovation (Damanpour, 1991), including organizational size, centralization, formalization, differentiation, professionalism and complexity (for example, the Aston Studies). However, the findings from structuralist research have been inconsistent – for example, structural complexity has been found both to increase innovation (Hage and Dewar, 1973) and to reduce innovation (Blau and McKinley, 1979). Contingency theories try to overcome these limitations by identifying the conditions in which causal relationships hold true. For example, Zaltman et al. (1973) suggest that the influence of structural variables will be contingent on whether one is focusing on the early stages of the innovation process or the later stages (initiation versus implementation). Hence, complexity may encourage initiation but it may impede implementation.

From a structural perspective, knowledge is assumed to be embedded in organizational and institutional systems and routines (see Table 6.1). The implication here is that, to manage knowledge, organizations need to be designed in such a way as to promote knowledge flows across boundaries (for example, through matrix structures or cross-functional teams). Again, rationality is stressed, since organizations are seen to adapt to their environments as appropriate to the goals of the organization. A key strength of this perspective is that it recognizes the constraining influence of social context on action. However, this is also a limitation, since it de-emphasizes the ways in which individual actors and organizations proactively shape their environment. Moreover, it fails to acknowledge that organizations and their environments are not objective realities. Rather, as Weick (1995) so eloquently points out, environments are enacted – we use our knowledge to make sense of, and construct, our environments. While there are clearly differences between individualist and structuralist perspectives, there are also some important similarities. They both adopt a 'normative-variance' approach to organizational innovation, treating innovation as a variable dependent on individual or organizational factors. Moreover, both tend to reify knowledge. Thus they assume that there are comparatively stable, codifiable bodies of knowledge (either located in the individual or in

the organization) that, when pieced together, determine how, when and if innovation will happen. They also adopt a linear view of the innovation process, seeing this as dependent on the movement of knowledge from one type, or location, to another (for example, tacit to explicit – Nonaka, 1994). This linear view remains pervasive in the thinking of many managers and policy-makers, reflected in numerous initiatives aimed at the improvement of 'knowledge transfer' or the capture of 'best practice' (Massey et al., 1992; Mytelka and Smith, 2002). However, as we discuss below, there are many problems with this linear view of the innovation process.

The interactive perspective

In contrast to the linear view, an *interactive* perspective has been flagged as a more realistic way to describe innovation processes. This depicts innovation as occurring through the interactions between the practices of individuals and groups and the social contexts in which they are located. Central to this perspective is the idea that, by developing more interactive and collaborative modes of working, for example through the development of networks and joint practices, knowledge that is distributed across social and organizational boundaries can be recombined and integrated in new, often unpredictable, ways to produce new products, services and processes (Rothwell, 1994; Kline and Rosenburg, 1986). While the interactive perspective has been gaining in popularity, different authors have focused on different aspects of interactivity (for example, interaction across groups and organizations versus interaction across episodes of the innovation process). This results in conceptual confusion when considering the implications for managing knowledge. To help resolve this, we identify below three different aspects of the interactive nature of innovation processes, drawing from existing literature:

1. Interaction between structural influences and the actions of individuals

Slappendel (1996) focused on this aspect of interactivity, suggesting a duality other than the traditional dualism between structure and action (Giddens, 1984). From this perspective, innovation is influenced by, and influences, wider institutional environments. Innovation behaviour is both afforded and constrained by the organizational and institutional context. As such, any innovation is shaped by organizational and societal structures and cultures as well as by individual and group behaviour and attitudes. Similar concepts have also been advanced by students of regional economies, as for instance the theory of 'innovative milieus' (Camagni, 1995). This aspect of interactivity emphasizes that it is important to adopt a multi-level analysis when exploring any innovation process, since a focus on only one level (for example, the individual, the organizational or the institutional) will overlook reciprocal interactions between action and structure.

2. Interaction between different phases or episodes of the innovation process

This aspect of interactivity recognizes that innovation is not a linear process from conception, through design, to implementation and diffusion but instead is typically an iterative process where recursivity is the norm and phases/episodes are conflated (Robertson et al., 1996; Clark et al., 1992; McLoughlin, 1999). Von Hippel (1988), for example, has illustrated that users can play a decisive role across all phases of the innovation process in the scientific instrument sector. Other research has shown how processes of implementation occur in parallel to, rather than following from, processes of diffusion (see, for example, Fleck's 1994 discussion of 'innofusion' in the development of manufacturing technology). This suggests the need for processual research (Pettigrew, 1985, 1990) in order to explore the dynamic and recursive nature of the production of knowledge through innovation processes over time. By contrast, the traditional linear model creates a false divide between the creation of knowledge by producers in one context and its application by users in another.

3. Interaction between different stakeholders, within and across organizational boundaries

This aspect of interactivity stresses the involvement in the innovation process of individuals from different departments, disciplines, professional backgrounds and organizations, each with potentially a different world view (Dougherty, 1992). Empirically, authors such as Parthasarthy and Hammond (2002) show that high levels of functional integration across the whole product development process predict high levels of product innovation, hence claiming that interactivity makes a difference as a moderating factor. This suggests the need to address multiple stakeholder perspectives in understanding innovation. For example, while one group of stakeholders may assess an IT innovation project as a 'success', another group may define it as a 'failure' (Wilson and Howcroft, 2005, forthcoming).

The three dimensions of interactivity outlined above are not mutually exclusive – the interplay between the broader context and individual action, for example, will be related to the perceptions and interests of different stakeholders during the innovation process, for example. However, they are qualitatively different: the first from an appreciation of levels of analysis (individual, organizational), the second from an appreciation of temporality (innovation episodes); and the third from an appreciation of pluralism of perspectives, understandings and interests (multiple stakeholders). We can, therefore, use these different aspects of interactivity to explore the knowledge management issues and challenges that arise during innovation processes. We do this below by drawing on case examples from our own research. Given space limitations, we describe one case in detail and also provide a number of brief vignettes as illustrative examples.

4. Interactivity and knowledge management challenges – empirical examples

Case: Hospital case (Newell et al., 2003)

Midlands NHS Trust Hospital is one of a large number of Trusts in the UK that together make up the National Health System (NHS). The NHS has been under intense government pressure to improve efficiency. One of the areas targeted by the government as in need of change is the cataract diagnosis and treatment procedure. Cataract surgery, which is a 20-minute procedure, represents 96 per cent of the ophthalmology workload. In most NHS trusts, including this one, cataract diagnosis and treatment had traditionally involved the patient in a long series of visits to various specialists. Typically, patients would first go to their optometrist (the high-street optician), believing that deteriorating eyesight implied they were in need of a new prescription. However, when optometrists ascertained that the problem was actually cataracts, they would refer the patient to his or her general practitioner (GP) for a 'proper' (that is, medical) diagnosis. After a visit to the local GP who, not being an eye specialist, generally relies on the diagnosis of the optometrist, the patient would be forwarded to the hospital consultant for further examination. The patient would then go on a waiting list and would eventually be called for a brief meeting with the consultant, who would usually confirm the optometrist's original assessment. The patient would then have to make a separate appointment with a nurse for a physical examination to ensure that they were healthy enough for the surgery. Only when all of these visits were complete would the patient be placed in the queue for obtaining a date for cataract surgery. In many trusts, the lead-time for cataract surgery is over 12 months. Post-surgery, another visit to the consultant is scheduled to check on the patient and then the patient is referred back to the optometrist for a new pair of glasses. Therefore, it takes patients at least six visits and often well over a year to have a routine, 20-minute, outpatient, surgical procedure.

Given the complex and drawn-out nature of this process, a new re-engineered cataract diagnostic and treatment practice was seen as potentially beneficial by those in the Midlands NHS Trust. To facilitate that change, a designated member of the hospital's transformation team[1] was assigned to the process. This transformation team member gathered a team of eye experts from both the hospital and the community to discuss ways of reducing surgery lead times and improving patient satisfaction. Members of the cataract team included a head nurse in the eye unit, a hospital administrator, general practitioners, a set of optometrists from the local community and a surgical consultant, who was instrumental in championing the need for change and in leading the change process. Team meetings were held in the evening to facilitate attendance and were led by

the transformation team member. Minutes, flow charts and other necessary documentation for the process were produced by the transformation team member and distributed to all team members after each meeting. In total, approximately five project-team meetings were held over a six-month period.

The outcome of this innovation process was that a number of changes to the existing practice were made. Visits to the patient's GP were no longer essential; the roles in the process of the consultant and the nurse were eliminated. Instead, optometrists were empowered to decide whether a patient needed cataract surgery. In doing so, they were required to fill out a detailed form that provided the consultant with specific information about the nature and severity of the cataract and to call the hospital and book a time for the patient's surgery. For their additional responsibility, the optometrists were given some extra training and received a small amount of compensation from the Trust. The preliminary pre-operation physical was replaced with a self-diagnostic questionnaire that each patient was required to fill out and return to the hospital before surgery. Nurses telephoned each patient before surgery to check the patient's details and answer any questions. Post-operation consultant appointments were also replaced with follow-up telephone calls.

The new cataract procedure resulted in a number of efficiency gains. Lead times were radically reduced from over 12 months to six to eight weeks. In addition, theatre utilization rates improved due to the addition of an administrator whose sole responsibility is scheduling theatres. Finally, and most importantly, according to follow-up phone conversations with cataract project patients, patient satisfaction improved dramatically. Moreover, busy GPS were pleased to avoid unnecessary appointments. However, attempts to diffuse this innovation to other NHS trusts were not successful.

Vignette 1: Brachytherapy example (Swan et al., 2002)

Another good example of interactive innovation has been the development of brachytherapy treatment for prostate cancer in Europe. In contrast to traditional methods (surgery or radiation therapy), this new treatment involves irradiating the tumour from within, by accurately implanting low dosage radioactive iodine seeds directly into it. Because the treatment involves both surgical and radiological skills, multi-disciplinary teams of surgeons, radiation oncologists, general physicians and nurses need to work together in both the diagnosis and treatment of the patient. This requirement for collaborative working has been a major challenge in the development of this innovation. More specifically, in this case the major issue centred on persuading powerful groups of surgical oncologists to accept the treatment as a valid alternative to surgery and to jointly develop processes for collaborative work with, relatively less powerful, radiation oncologists.

This proved to be a challenge in part because the new treatment engendered a limited shift in the balance of professional power from the oncologists to the radiologists. Key to overcoming this challenge were the actions of the particular bioscience firm manufacturing the iodine seed implants. Instead of directly marketing their product to unwilling consumers (medical professionals) the manager in this firm went to significant effort to mobilize a new 'community of care' around the prostate cancer disease, comprising multiple professional groups and patients. Bonded by a common interest in curing the disease, this community came to share knowledge around the treatment of the disease and the practices of brachytherapy treatment.

Vignette 2: Research team example (Newell and Swan, 2000 and Newell et al., 2001)

Exploring academic research as an innovation process provides a third example of the different aspects of interactivity involved. Newell and Swan (2000), for example, describe an academic research project, sponsored by the UK government, which involved four principal investigators and four research assistants as well as an administrator at different academic institutions in the UK. Interactivity was necessary in this project to ensure integration of knowledge, but the group failed to develop the necessary interactive practices to ensure genuine collaboration and knowledge integration. The main reason for this was that the research group was not able to overcome the knowledge boundaries created by their different disciplinary and epistemological perspectives (cf. Carlile, 2002). For example, one of the researchers came from a highly positivist tradition and another had what could be described as a weak constructivist position. These particular researchers were unable to reconcile these different positions. The outcome of the collaboration was thus relatively limited because of the research group's inability to develop a common understanding and a unifying perspective. Moreover, the difficulties which were experienced in this case were also, in part, explained by the constraints imposed on their interactive practices as a result of the institutional context (Newell et al., 2001). In particular, the funding agency required the project team to outline deliverables from the project before the research had actually been undertaken, thus restricting the degree to which knowledge could emerge out of their interaction. In addition, publications were a major basis for career advancement but the disciplinary-based educational system in the UK did not support multidisciplinary publications and so discouraged knowledge integration.

5. Dimensions of interactivity and the production of knowledge

We can now explore the examples above in terms of the different aspects of interactivity discussed earlier.

Interactivity between structure and action

The cataract case is only explicable if we take into account the broader institutional context within which the project team was operating. Thus the NHS was striving to encourage hospital trusts to improve efficiency in key areas. This aspect of the institutional context conferred a legitimacy on the innovation that encouraged different stakeholders to become involved and to share and create the knowledge, which led to their eventually defining and introducing the new cataract diagnosis and treatment process. In this sense, then, the institutional context promoted the integration of knowledge distributed across the various stakeholders that supported the innovation process.

However, other aspects of the institutional context actually served to constrain the diffusion of this innovation. In the UK there exists a *national* health service, free to all British citizens, as well as a much smaller *private* health service for those who can pay. The interplay between the public and private services is an important structural consideration that potentially influenced the behaviour of the actors involved, constraining the diffusion of the new process. Long waiting lists for National Health Service treatment provide an incentive for some patients to opt to pay for their operation from the private service. Consultants in UK hospitals can significantly boost their incomes from their NHS work by doing private healthcare work. Reducing patient waiting lists in the NHS may not, therefore, be seen by all hospital consultants to be in their best interests, albeit from the perspective of other stakeholders this may be very beneficial. While other issues were involved in explaining the difficulties of innovation diffusion in this case (see the third subsection below), this aspect of the institutional context certainly had some influence. The institutional context thus both afforded and constrained knowledge-sharing and knowledge creation, as predicted by an interactive innovation perspective.

Similar institutional dynamics were also at play in relation to the brachytherapy case in so far as existing power structures amongst established medical professions militated against the acceptance of the new treatment. Significant efforts on the part of a medical device company marketing the equipment for the new treatment had to be made to promote the development of a new community of practice (including both oncologists and radiologists) around the disease in order to overcome the natural reluctance of the oncologists to engage with the proposed new method of treatment. In relation to the creation of knowledge by the team of academic researchers, the institutional context afforded the instigation of the research project by this particular group by providing the opportunity for a large interdisciplinary research team to be funded. At the same time however, the activities of the research team were also restricted by their institutional context. Firstly, the need to define for the funding body at the

outset of the three-year project what was actually going to be produced constrained the extent to which their output could emerge from their interactions. Secondly, there were problems in relation to publishing the output from their interdisciplinary efforts because the established academic journals tend to have very strong disciplinary orientations. These constraining influences led to the research project's being divided into three separate mini-projects, each oriented to a different disciplinary perspective.

Here the theoretical lens of institutional theory (Scott, 2001) is helpful in exploring the ways in which the environment shapes (and is shaped by) knowledge integration processes that support innovation. Institutional theorists focus on understanding the ways in which innovations arise and diffuse across an organizational field (for example, DiMaggio and Powell, 1983), recognizing that the seeds of change are located both inside and outside the institutions. In particular, institutionalists examine how when regulative, normative and cultural-cognitive elements become misaligned, tensions arise that produce divergent schemas and recipes for action. Thus, institutionalists recognize the need to incorporate multiple levels of analysis, as Scott (2001) so clearly states: 'Social actions and structures exist in dualistic relation, each constraining and empowering the other. And social structures are themselves nested, groups within organizations or networks of organizations, organizations within fields, fields within broader societal and trans-societal systems. Although every study cannot attend to all levels, analysts should be aware of them and craft designs to include critical actors and structures engaged in maintaining and transforming institutions' (p. 203).

Interactivity between different stakeholders

The cataracts case indicates the importance of engaging in shared practice in generating knowledge for successful innovation. The process of re-engineering the cataract diagnostic and treatment procedure involved building meaning out of often conflicting and confusing data. This was only possible by bringing together a number of different stakeholders with different knowledge and understandings who were willing to work together in the project and share their (largely tacit) knowledge. Here a crucial aspect of the 'new' knowledge created was a holistic overview and understanding of the cataract practice, as it currently existed, which could then be re-engineered. This knowledge did not exist before the formation of the project team – each professional group had only a partial view of what constituted the particular routine or practice (Shani et al., 2000; Tsoukas, 1996) – and so had to be generated through interaction and negotiation. Bringing together individuals from different professional backgrounds was necessary in order that each group could understand and appreciate the skills and capabilities of other groups. Without this collective practice, the knowledge

and understanding of the different groups would have remained unconnected and isolated, and preconceived notions of the limits of the professional competence of others would not have been challenged.

This case example echoes Boland and Tenkasi's (1995) observations about the importance of being able to understand the perspectives of 'others' (perspective-taking) in multi-disciplinary teams. More importantly they stress the need for developing a shared perspective (perspective-making) across the team for successful outcomes. In the cataracts case, the team did achieve this shared perception of the whole process and could then reconfigure which professional groups should take responsibility for different aspects of the process. Through the exchange within the project team, all of the professional groups involved in the process also started to recognize the value of, and under-utilization of, the optometrists' skills and expertise. Thus, micro-level shifts in the relative power of different professionals occurred through the practices of working together on this particular problem. Without this type of interactivity, the innovation process could not have moved forward. This accords with the conclusions of Fitzgerald et al. (2002). They also emphasize – again analysing the adoption and diffusion of innovations within health care – how knowledge is not 'objective' but tends to be continually contested and negotiated, particularly because of the presence of multiple professions. This results in adoption decisions being 'weighed', in the sense that different criteria – not just 'objective' scientific evidence – are balanced against each other and crucially shaped by networks and opinion leaders. The research team and the brachytherapy examples similarly show the influence of the contested and negotiated nature of situated knowledge on innovation processes, to the extent that in the research team example the team members were not really able to innovate because they were simply unable to develop trust in each other's ideas, coming as they did from different disciplines and epistemological positions.

Here, theoretical lenses of social constructivism (for example, Tsoukas and Vladimirou, 2001) and related frameworks on communities/networks of practice (for example, Brown and Duguid, 2001; Lave and Wenger, 1991), which emphasize the social embeddedness of knowledge, are useful. These literatures are linked by their attention to the processes of *validating* or *legitimizing* knowledge: they assume that knowledge claims ('truths') are co-constituted with political interests and institutionally embedded within network structures (Contu and Willmott, 2003). Therefore, understanding political, social and professional structures and practices surrounding the production and integration of knowledge during innovation processes is important.

A community of practice is defined as 'an activity system about which participants share understandings concerning what they are doing and what it means in their lives and their community' (Lave and Wenger, 1991,

p. 98). A critical feature of such communities is that they emerge spontaneously through shared practice and are therefore typically made up of people from many functions, cutting across formal organization structures and hierarchies. These multi-disciplined arenas share a common identity and so provide fertile ground for the open exchange of knowledge and learning within and across organizations (Lesser and Everest, 2001). Brown and Duguid (2001) argue, therefore, that communities of practice are important arenas for local invention because they engage in constant improvisation in order to traverse the limitations of both the formal organization and canonical practice. Evidence of the positive effects of communities of practice and networks of practice on innovation comes from examples of local adaptations of work practices among, for example, scientists and technicians, in response to new problems (Orr, 1996; Brown and Duguid, 2001).

However, communities of practice can also produce barriers to innovation as they interpolate different identities and world views that may constrain knowledge integration across communities (Swan et al., 2002). Thus knowledge leaks within communities of practice but sticks across them (Brown and Duguid, 2001). This can potentially have important consequences for interactive innovation that involves stakeholders from different communities of practice coming together (Hage and Hollingsworth, 2000). Here, then, it is likely that the constraining effects of communities of practice are likely to be more acute (Brown and Duguid, 2001; Swan et al., 2002). This aspect of interactivity therefore disrupts existing communities, as was the case in the brachytherapy example (Swan et al., 2002). Thus where interactivity involves bringing together multiple professional and organizational groups, innovation relies as much upon the *dis*-embedding of existing knowledge/practice as it does upon the creation of new knowledge (Giddens, 1984). However, as the research team vignette illustrated, the influence of these professional communities can, at times, be so strong that knowledge integration is not achieved.

The focus on knowledge legitimization emphasizes that interactive innovation is intimately tied up with social regimes of power. In line with our epistemological stance, power is not treated as a property of a particular individual or group, but as co-constituted with social practice and networks of social interaction (Callon, 1986). Thus, as seen in the brachytherapy case, biomedical knowledge is contested as medical professionals and scientists, with particular vested interests, seek to sustain power and control within their own knowledge domains and over their own work practices (Friedson, 1970; Abbott, 1988; Drazin, 1990). It follows that existing powerful networks, such as professions, are in the position to shape innovation processes that require the integration of knowledge across such networks (Brown and Duguid, 2001; Hage and Hollingsworth, 2000).

Interactivity between different episodes of the innovation process

The project described in the cataract case appeared to be successful in part because of the strong championing and leadership provided by the consultant involved. In addition, the transformation team provided resources and expertise to facilitate the knowledge generation process. Together, these factors suggest that the Midlands Hospital Trust provided a very 'receptive context' for innovation (Pettigrew et al., 1992) that was not provided in other trusts.

However, there is, we argue, a more fundamental reason why innovation diffusion did not occur. Specifically, our analysis leads us to conclude that knowledge of the new cataract diagnosis and treatment process could not readily transfer to other contexts because knowledge diffusion does not occur independently of, or in sequence to, knowledge generation. Specifically, in the Midlands Trust diffusion of the idea coincided with the development of social processes and practices needed to generate the idea. The practice of the diagnosis and treatment of cataracts was sustained by the interaction of the various collective actors and existed only through this social interaction (Gherardi and Nicolini, 2000). As Cook and Brown (1999) observe, it is groups, not individuals, that possess the 'body of knowledge'. Once developed, the new practice was captured in the form of a template for 'best practice' and made available to other NHS hospital trusts. However, when others considered the new template, they dismissed it as 'unworkable' in their context. Those in other trusts had not experienced the knowledge generation processes and, therefore, had come to appreciate neither how the whole cataracts treatment process worked nor the skills and interests of different stakeholders. As a consequence, they could not understand how the knowledge generated (the template for best practice) could apply in their own context. In Boland and Tenkasi's (1995) terms, the professionals in other trusts had not sought to develop a collective or shared perspective on the new practice (perspective-making) and so could not apply the template that had been generated at Midlands Hospital (Rowley, 2000).

This implies that, for diffusion to be successful in other trusts, it would need to have been accompanied by a knowledge generation process in the new context, which would allow those involved to understand how to apply the knowledge generated. This mirrors Szulanski's (1996) finding that absorptive capacity is the biggest impediment to the internal transfer of knowledge or innovation diffusion. Szulanski's finding highlights our contention that any given work practice is culturally mediated and, therefore, is the outcome of a web of knowledge formed through social participation, material working conditions and negotiated interpretations (Star, 1996). In this 'other' context, pre-existing ideas about normal practice limit the absorptive capacity of those involved (Cohen and Levinthal, 1990). For example, consultants that had not been through the knowledge generation

process undertaken in the Midlands Trust were working from the assumption that 'opticians cannot accurately diagnose cataracts'. Acceptance of a new practice, which renders obsolete these taken-for-granted assumptions, is unlikely (Orlikowski, 2000), highlighting the need for interactivity across the different episodes of an innovation process.

Here, then, we can return to our assumptions about the nature of knowledge. In this chapter a social constructivist view of knowledge was adopted, which assumes that knowledge is essentially situated in, and inextricable from, social processes and practices (Berger and Luckmann, 1966). This situated view is often seen to be incommensurable with a view that sees knowledge as a resource, property or entity possessed by an individual, group or organization (Nonaka, 1994). Nevertheless, Cook and Brown (1999) have recently tried to bring these two views of knowledge together. They suggest that both views are useful and simply represent two different, albeit related, underpinning epistemologies: the epistemology of possession (knowledge) and the epistemology of practice (knowing). It is, they suggest, the 'generative dance' between knowledge and knowing that is important. Thus, knowledge as something possessed must be practised in a specific context to be meaningful. In this sense, knowledge is a 'tool of knowing' (Cook and Brown, 1999), making knowledgeable action, or knowing, possible.

This suggests that there are two complementary ways of looking at knowledge, each with different implications for knowledge management. Thus the epistemology of possession implies that tacit knowledge can be made explicit and transferred (for example, through the use of IT systems) independently of practice. In contrast, the epistemology of practice implies that knowledge management needs to allow the generation of new shared practice, or a shared context for knowing (Tsoukas, 1996). That said, it is important to recognize that knowledge is always a combination of tacit and explicit knowledge (Polanyi, 1966). While the knowledge as possession school tends to argue that tacit knowledge can be made explicit, Cook and Brown (1999) make it clear that tacit and explicit knowledge are inherently different and cannot simply be converted from one form to the other. Tsoukas (1996) frames this differently when he argues that tacit and explicit knowledge are mutually constituted. Thus we need both tacit and explicit knowledge to be able to engage in any given activity or practice and we need tacit knowledge to make sense of explicit knowledge. For example, in the NHS case the explicit knowledge about the new cataract practice made no sense to those who had not transformed their implicit understanding of the roles and responsibilities of different groups involved in the cataract process. The recognition that knowledge is a possession, and yet is also inherently embedded in practice, is helpful and suggests that both views of knowledge are valid. Thus, while these views suggest different approaches to managing knowledge, they are not necessarily mutually exclusive, and might even be complementary.

6. Conclusions: Challenges for future research and practice

Our discussion of the issues and challenges of sharing and integrating knowledge to support innovation processes leads us to conclude that future research and practice on knowledge management, where the purpose is innovation, must unpack the different dimensions of interactivity explored here. Thus our analysis suggests that knowledge management research and practice needs to address different levels of analysis (interactivity between agency and structure), multiple stakeholder perspective (interactivity between different stakeholders) and the episodic nature of the innovation process (interactivity across innovation episodes).

In terms of the importance of exploring different levels of analysis, our examples have demonstrated the need to understand the creation of knowledge in innovation as a 'cultural practice' that is shaped by macro-level institutional and organizational arrangements and the actions of individuals and groups (Murray, 2001). Consequently, there is a need for a multi-level approach to knowledge management that is able to tease out the constraints and opportunities for knowledge management created by institutional and organizational contexts. For example, simply fostering links across professions (for example, through interdisciplinary fora or networks) may not result in knowledge integration where the organizational and/or institutional context reinforces separation between the practices of those professionals

In relation to multiple stakeholders, our examples have illustrated how innovation often involves stakeholders from different professions, disciplines and communities/networks of practice, each with their own particular norms, expectations and practices surrounding how knowledge is produced and legitimated (Knorr-Cetina, 1999). These differences in understanding create problems for knowledge integration, as we have seen in the example of our research team as well as in the brachytherapy case. This implies that knowledge management theory and practice needs to address the values, assumptions and invested practices that underpin the knowledge that different stakeholders hold (Carlile, 2002). For example, Robertson et al. (2003) found that lawyers are more likely than scientists to rely on codified forms of information in creating knowledge and explain this in terms of epistemic differences between these professional groups (Halliday, 1985). This has important implications for managing knowledge, since it implies that some groups (for example, legal professionals) may be more likely to respond favourably to codification strategies than others (for example, R&D professionals) because these align better with their existing work practices and values.

Finally, we have discussed the importance addressing the episodic nature of the innovation process and the interactivity between design, diffusion and implementation. Much existing theory and practice in knowledge

management is still heavily underpinned by linear assumptions regarding the production of knowledge – that is, that is, that knowledge produced in one context can be more or less directly transferred to another (for example, Hansen, 1999). While there is much debate surrounding the appropriate vehicle for knowledge transfer in different contexts (for example, whether it should be IT systems or social networks), the assumptions of linearity still remain. In contrast, the interactivity between innovation episodes highlighted here suggests that the real challenge for knowledge management is to abandon these linear assumptions. What, for example, would a knowledge management initiative look like if the starting assumption were that knowledge transfer is impossible?

Note

1 The transformation team is a set of eight individuals who are charged with re-engineering hospital processes within this particular Midlands Trust. Other current projects include a national initiative on lead-time reduction, a project on diabetes and eyes and a project on hip replacement surgery. At any one time, numerous re-engineering projects are underway at the trust.

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