Communities of Practice? Varieties of Situated Learning

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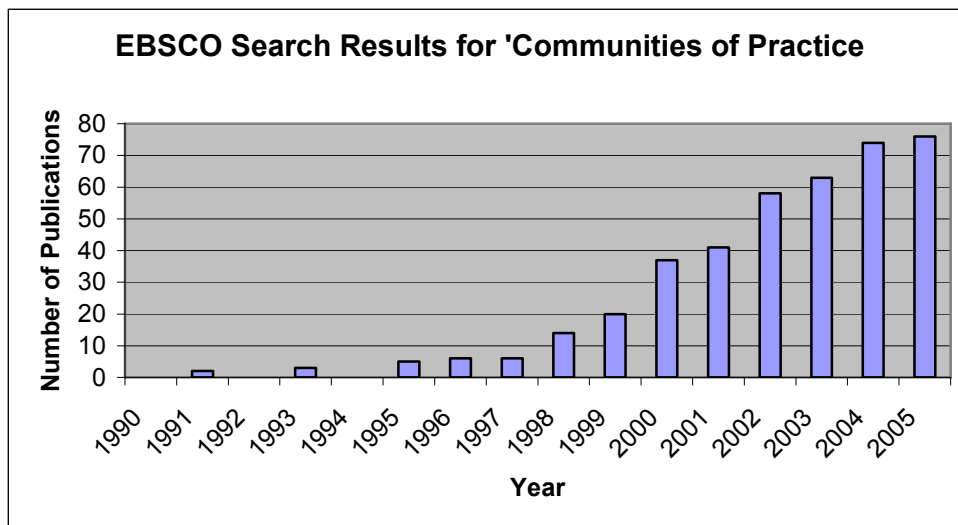
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Introduction

In recent years the role of communities in the process of learning and knowledge generation has attracted much attention from across the social sciences interested in knowledge as a situated practice. This interest has influenced management literature and practice at an unexpected pace and a level of flurry thanks, in part, to the consultancy role of some of the pioneers of research on communities of practice (CoPs), most notably Seely Brown, Wenger, and Duguid.

The CoP approach has emerged from academic research into situated learning and actual working practices, such as insurance claims processing and photocopy machine repair (Lave and Wenger, 1991, Wenger, 1998, Orr, 1996). Subsequently, it has been further articulated in the academic literature on management and is currently being applied as one of a number of knowledge management tools in many organisational settings. A large body of literature has developed concerning CoPs since Lave and Wenger's original use of the term in1991[1]. In May 2006 a search for the term 'Communities of Practice' in the *EBSCO Business Source Premier* database provided 425 references to papers. As illustrated in Chart 1 the number of papers concerning CoPs is growing year on year indicating its increasing popularity in the academic discourse.[2]

Chart 1

Sources: Chart derived from a search of EBSCO[3] in May 2006.

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[1] An extensive bibliography is attached.
[2] Abrahamson and Fairchild (1999) suggest that discourse on and the adoption of management practices co evolves.
[3] *EBSCO Business Source Premier*, provides full text for nearly 7,600 scholarly business journals and other sources, including full text for more than 1,125 peer-reviewed business publications. This database offers information in nearly every area of business.

This body of literature includes theoretical, conceptual, and review papers together with critiques and papers reporting the findings of empirical studies. Empirical investigations range from CoPs in public services, such as education and healthcare, to learning in private business organisations and extra-organisational environments including financial services, creative and innovative organisations and networks, craft-based learning environments, on-line communities and a range of miscellaneous contexts (e.g. a witches' coven (Merriam et al., 2003)).

The potential of CoPs has already attracted much attention in management literature and practice and it is also influencing wider debates on the knowledge economy. It is therefore no surprise to find that CoPs are increasingly receiving attention from academics and practitioners interested in enhancing learning and innovation in an extra-organisational context, such as in policies for regional and national regeneration.

Drawing on existing research directed largely at the intra or inter-organisational level, this paper aims to provide insights into the value of CoPs within diverse organisational settings as well as for regional innovation. While we argue that the framework does have value beyond the intra- and inter-organisational context, we suggest that there is a need to develop our understanding of CoPs by differentiating between them in relation to their spatial reach, social and sectoral context, and the nature of the knowledge around which they coalesce. The blanket use of the term risks weakening the original conceptualisation of CoPs as learning and knowledge generating entities situated in certain kinds of social practice.

We begin by exploring early conceptualisations of CoPs (Lave & Wenger, 1991; Wenger, 1998). We then consider a variety of communities. Drawing on an extensive review of CoPs literature we give particular attention to four types of community that display specific but overlapping knowledge dynamics: craft/task-based, professional, expert or creative, and virtual communities. Following the presentation of a tentative typology of CoPs, each of the four communities is considered in turn. In the final section, on the basis of our review of the literature, we consider the significance of CoPs for organisational knowledge management strategies before reflecting on the spatiality of knowledge production through communities.

1. What are Communities of Practice?

The concept of communities of practice was originally developed by Lave and Wenger (1991) in a study of situated learning in the context of five apprenticeships: Yucatec midwives; Vai and Gola tailors; naval quartermasters; meat cutters; and non-drinking alcoholics. Lave and Wenger (1991, p. 98) argue that a community of practice, which they define as 'a system of relationships between people, activities, and the world; developing with time, and in relation to other tangential and overlapping communities of practice' is an intrinsic condition of the existence of knowledge. Brown and Duguid (1991, 1998), drawing on the work of Orr (1996), among others, have further developed the approach. Moreover, through a study of an insurance claims processing office, Wenger (1998) developed a detailed understanding of the dynamic operation of communities of practice. The communities of practice approach focuses on the social interactive dimensions of situated learning, a subject that has received attention from a variety of other organisational researchers (see, for example, Barley and Orr, 1997; Blackler, 1995; Boland and Tenkasi, 1995; Gherardi, et al., 1998; Carlile, 2002).

According to Wenger (1998, p. 55), within communities of practice meaning is negotiated through a process of participation and reification. Wenger (1998, p. 58) defines the concept of reification as the process of giving form to experience by producing objects. 'Any community of practice produces abstractions, tools, symbols,

stories, terms, and concepts that reify something of that practice in a congealed form' (Wenger, 1998, p.59). Such forms take on a life of their own outside their original context where their meaning can evolve or even disappear.

For Wenger (1998) communities of practice are important places of negotiation, learning, meaning, and identity. Wenger (1998, pp. 72-84) identifies three dimensions of the relation by which practice is the source of coherence of a community. Firstly, members interact with one another, establishing norms and relationships through *mutual engagement*. Secondly, members are bound together by an understanding of a sense of *joint enterprise*. Finally, members produce, over time, a *shared repertoire* of communal resources including, for example, language, routines, artefacts, and stories. Furthermore, Wenger (2000, p. 227-8) distinguishes between three modes of belonging to social learning systems. Firstly, *engagement* is achieved through doing things together, for example talking, and producing artefacts. Secondly, *imagination* involves constructing an image of ourselves, of our communities, and of the world, in order to orient ourselves, to reflect on our situation, and to explore possibilities. Finally, *alignment* involves making sure that our local activities are sufficiently aligned with other processes so that they can be effective beyond our own engagement.

The existence of a community of practice may not be evident to its members because, as Wenger (1998, p.125) notes, 'a community of practice need not be reified as such in the discourse of its participants'. Nevertheless, he argues, a community of practice does display a number of characteristics including those listed in Table 1.

Table 1   Key Characteristics of a Community of Practice

- Sustained mutual relationships — harmonious or conflictual
- Shared ways of engaging in doing things together
- The rapid flow of information and propagation of innovation
- Absence of introductory preambles, as if conversations and interactions were merely the continuation of an ongoing process
- Very quick setup of a problem to be discussed
- Substantial overlap in participants' descriptions of who belongs
- Knowing what others know, what they can do, and how they can contribute to an enterprise
- Mutually defining identities
- The ability to assess the appropriateness of actions and products
- Specific tools, representations, and other artefacts
- Local lore, shared stories, inside jokes, knowing laughter
- Jargon and shortcuts to communication as well as the ease of producing new ones
- Certain styles recognised as displaying membership
- A shared discourse reflecting a certain perspective on the world

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Source: compiled from Wenger (1998, pp. 125-6).

The CoP approach is one among a number of practice-based approaches to learning and knowledge generation. Gherardi (2006, p. 38), in her recent review of such approaches, identifies three types of relations established between practices and knowledge. The first of these is a relation of containment, with knowledge as a process that takes place within situated practices. The second is a relation of mutual constitution, with the activities of knowing and practising tangled together and shaping each other. The third is a relation of equivalence, such that practising is the same as knowing in practice, whether the subject is aware of it or not. Gherardi (2006, p. 39) goes on to outline four main reasons for adopting a practice-based approach to learning and knowledge, which can be summarised as follows:

- To go beyond problematic dualisms like mind/body, actor/structure, human/non-human.

- To question the primacy of the actor and the individual action as the building blocks of social phenomena.

- To see reason as a practice phenomenon and depict language as a discursive activity.

- To pay due attention to the materiality of the social world.

Since the study by Lave and Wenger (1991) there has been an explosion of research on CoPs, and broader practice-based approaches, to learning and knowledge generation in a variety of diverse settings. Chart 1, above, reflects this in terms of the growing number of publications concerning CoPs. Much of this literature, whether it reveals the existence of CoPs or reports on the application of the framework to particular learning and knowledge generation contexts, works with definitions that are far from the original conceptualisation of CoPs as relatively stable communities of face-to-face interaction between members working in close proximity to one another, in which identity formation through participation and the negotiation of meaning are central to learning and knowledge generation. Alongside the increasing popularity of communities of practice research, the approach has begun to attract criticism concerning, for instance, the neglect of power (Contu and Willmott, 2003; Fox, 2000), its failure to take into account pre-existing conditions such as habitus and social codes (Mutch, 2003), as well as its widespread application within organisational studies beyond its original focus on situated learning (Handley et al. 2006), and the term 'community' itself, which is problematic, embodies positive connotations and is open to multiple interpretations (Lindkvist, 2005, Roberts, 2006). Some of these concerns are taken up below in section 3, where we reflect on the finding of a review of the existing research on CoPs and practice-based approaches to knowledge generation and dissemination. It is, then, to an examination of this literature that attention now turns.

2. Varieties of Communities

Following a review of the now-extensive literature on CoPs, which revealed a degree of diversity that would be impossible to represent here, we have identified four distinct types of knowledge community with specific but overlapping knowledge dynamics: task/craft based communities, professional communities, expert or creative communities, and virtual communities. The first three types of community are distinguished from each other by the type of knowledge that they deal with. Virtual communities, however, do overlap with many of the first three communities which use ICT to facilitate the exchange of knowledge. Nevertheless, there are some CoPs that exist solely in a virtual manner: it is these with which we are primarily concerned

since they raise important questions about the nature of practice when it is disassociated from geographical space and face-to-face contact.

In addition, the four CoPs seem to capture distinct types of social interaction. For instance, for the task/craft based CoPs social interaction and knowledge exchange is situated in practices that require proximity between community members. They may also be mediated by particular artefacts, tools or work environments, requiring the development of kinaesthetic and aesthetic knowledge through the repeated practice of certain tasks under close supervision from core members of the community. The knowledge of professional CoPs is often well established and acquired through lengthy periods of training designed to absorb, largely through the application of intellectual and memory capacities, a given canon of knowledge and associated practice. In contrast, expert (including epistemic) and creative communities are primarily concerned with creating new knowledge, something that may necessitate continual challenging of the status quo.

In our coverage of the four groupings we sought to include a number of dimensions relating to the nature of the knowledge-generating process. The first of these is concerned with the nature of social interaction that sustains innovation and learning within the community. Aspects of this might include, for example, friendship, trust, shared identity, task orientation, and so on. For instance, we might expect to find the social interaction between craft and task-based workers to be quite different from that between professional workers, whose identity and reputation are underpinned by institutional structures rather than dependent on social interaction. Similarly, craft and task-based work often requires close proximity and face to face interaction between workers, a factor which will shape the nature of social interaction, as will the lack of proximity for those working in a spatially distributed network dependent on a combination of face to face and distanciated interaction such as face to screen.

The second dimension is the extent to which innovation is a central concern of the CoP, and the nature of its innovative activity in terms of whether it is radical, continuous or incremental. For example, it may seem reasonable to expect epistemic communities to display high propensities to innovate. Consequently, it is useful to note the differences between those communities that are concerned primarily with the advancement of knowledge, such as communities of physicists and molecular biologists, and international public policy makers (Knorr-Cetina, 1999; Haas,1990), and the craft based communities that are more concerned with the replication and preservation of skills together with incremental innovation, such as the flute makers, Xerox technicians, and insurance claims administrators (Cook and Yanow, 1993; Orr, 1996; Wenger, 1998). It would be wrong to portray the efforts of crafts-people and artisans as merely the replication of knowledge, for they are innovative in a number of ways. Firstly, each product is idiosyncratic, and, secondly, skills and techniques must continually develop to maintain their viability in a changing market and environmental context. Nevertheless, radical change is not the central purpose of craft-based innovative activity.

A third aspect concerning the knowledge generating process of the communities under consideration is the organisational dynamic and parameters of the community. For instance, is the community is managed in a decentred or hierarchical manner? Is it open or closed to the flow of knowledge from other communities? Related to these organisational characteristics is the degree of fluidity evident in the community and the enduring or transitory nature of its boundaries.

The fourth dimension, which relates to the boundaries of communities, is the extent to which they are connected to a wider organisational or environmental context, and whether these linkages impact on the innovative activity or capacity of

the community. From an organisational perspective whether knowledge is held in silos or able to move easily around the organisation will influence the level of innovation arising from the cross-fertilisation of ideas. At a broader environmental level, national or regional policy and regulatory practices may be important. For instance, innovations in professional communities, such as health and education, may be stimulated by the changing policy context, and innovation in craft-based activity in the construction sector may be constrained by health and safety regulation. Moreover, the more distributed a community the greater the possible number of external linkages that can impact on the innovation process.

Our review of the varieties of community begins with craft/task-based activities including those considered by the Lave and Wenger (1991) study of situated practice. The CoPs approach emerged from studies of craft/task based activity and there has consequently been much consideration of this literature. As a result, we do not review these studies in detail. Nevertheless, we do recognise the importance of this work and the insights that it offers for valuing the knowledge of an artisan nature as well as the continuous innovations generated from relatively routine work tasks such as insurance claims processing. We then move on to consider professional CoPs where we focus on the predominantly public sector activities of health and education. The reason for the public sector focus is two fold. Firstly, CoPs feature prominently in knowledge-management techniques currently being promoted and adopted in a variety of public sector activities to increase efficiency in activities that are largely knowledge-intensive. Secondly, public sector activity accounts for a large proportion of organisational activity in advanced countries. For instance, in the UK the public sector accounted for 20 percent of total employment in 2004, and 50 percent of this was in the health and education sectors (Hicks, et al., 2005). Then we consider expert and creative CoPs as examples of activity where the creation of new knowledge is of central concern, although this may be in conjunction with the replication of a significant body of existing knowledge as is the case for communities of scientific researchers. Finally we explore virtual CoPs beginning with distributed communities, which make use of virtual communication tools, before moving on to consider communities that exist solely in a virtual, online, context. A tentative typology of CoPs based on these four activities is presented in Table 2. Reviewing the learning and knowledge-generation activities of these diverse communities will provide the basis for our reflections on the cultivation of CoPs in section 3.

Table 2. A Tentative Typology of CoPs

Activity	Type of knowledge	Social interaction			Innovation	Organisational dynamic
		Proximity/ nature of communication	Temporal aspects	Nature of social ties		
Craft/task based	Aesthetic, kinaesthetic and embodied knowledge	Knowledge transfer requires co-location – face to face communication, importance of demonstration	Long-lived and apprenticeship-based Developing socio-cultural institutional structures	Interpersonal trust – mutuality through the performance of shared tasks	Customised, incremental	Hierarchically managed Open to new members
Professional	Specialised expert knowledge acquired through prolonged periods of education and training. Declarative knowledge. Mind-matter and technologically embodied. (Aesthetic and kinaesthetic dimensions)	Co-location required in the development of professional status for communication through demonstration. Not as important thereafter	Long-lived and slow to change. Developing formal regulatory institutions	Institutional trust based on professional standards of conduct	Incremental or radical but strongly bound by institutional/ professional rules. Radical innovation stimulated by contact with other communities	Large hierarchical managed organisations or small peer managed organisations Restrictions on the entry of new members
Expert/ Creative	Specialised and expert knowledge, including standards and codes, (including meta-codes). Exist to extend knowledge base. Temporary creative coalitions; knowledge changing rapidly	Spatial and/or relational proximity. Communication facilitated through a combination of face-to-face and distanciated contact.	Short-lived drawing on institutional resources from a variety of expert/ creative fields	Trust based on reputation and expertise, weak social ties	High energy, radical innovation	Group/project managed Open to those with a reputation in the field Management through intermediaries and boundary objects
Virtual	Codified and tacit from codified Exploratory and exploitative	Social interaction mediated through technology – face to screen. Distanciated communication Rich web-based anthropology	Long and short lived. Developing through fast and asynchronous interaction	Weak social ties; reputational trust; object orientation	Incremental and radical	Carefully managed by community moderators or technological sequences. Open, but self regulating.

Craft/Task Based Communities

The five apprenticeships originally examined by Lave and Wenger (1991) in their seminal study of situated learning cover craft or task based activities. They looked at Yucatec midwives; Vai and Gola tailors; naval quartermasters; meat cutters; and non-drinking alcoholics. Lave and Wenger explore the transition from apprentice to master as a transition from legitimate peripheral participation to full participation in a community of practitioners. They underline that 'learners inevitably participate in communities of practitioners and that the mastery of knowledge and skills requires newcomers to move toward full participation in the sociocultural practices of a community.' (p. 29). A key finding is that the master-apprentice relationship is not a central characteristic of learning. Instead, mastery resides in the organisation of the CoP of which the master is a part, and 'becoming a full participant certainly includes engaging with the technologies of everyday practice, as well as participating in the social relations, production process, and other activities of communities of practice' (p. 101).

The apprentices studied are learning to replicate a certain set of tasks within a particular sociocultural setting using skills acquired through practice-based learning. In the process of moving from legitimate peripheral participation to full participation and mastery of the required skills, individuals internalise knowledge gained through practice in the process becoming a midwife, tailor, quartermaster, meat cutter, or non-drinking alcoholic. Hence, learning and identity are closely connected.

Similarly, the claims processors in Wenger's (1998) study of CoPs in a large U.S. insurance company are concerned with replicating and sharing knowledge between members. In this case learning to process claims involves the acquisition of a range of skills necessary to be able to complete the tasks required for the effective and efficient handling of medical insurance claims. In this context, workers are putting codified knowledge into practice. Newcomers absorbed knowledge from a variety of sources including formal training and from working in a social context with more experienced co-workers. While much of the activity is standardised some claims are idiosyncratic, necessitating specialist knowledge. Part of achieving full participation in this community is gaining knowledge of who knows what in order to be able to access the knowledge required to process such claims.

Another classic contribution on this type of community is Orr's (1996) study of Xerox technicians involved in replicating and refining a certain kind of craft-knowledge through shared practice. Orr shows that, in the process of learning how to repair photocopy machines, the technicians are often involved in the co-production, with colleagues and clients, of knowledge pertaining to specific machines. Technicians learn to improvise: each machine has its own peculiarities. In this way they draw on a range of knowledge; from that codified in manuals to the aesthetic knowledge[4] embedded in their mental and physical senses. New methods of repair are developed in this way and shared in the community of technicians through the recounting of stories from the field during informal meetings over breakfast and lunch.

A good example of a 'purer' craft environment is Cook and Yanow's (1993) study of learning in the manufacture of flutes. Cook and Yanow (1993) describe a recursive work culture in small workshops where flutes are constructed by a group of people in close proximity, each focusing on a particular task. As the flute is passed from one

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[4] Strati (2003, p. 54) defines aesthetic knowledge as 'the form of knowledge that persons acquire by activating the specific capabilities of their perceptive-sensorial faculties and aesthetic judgement in the day-to-day lives of organisations.'

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person to another, the recipient assesses the work of the previous person, returning it for further work if it 'does not feel right'. The production of the flute depends on the group rather than the individual, with knowledge expressed and communicated through the medium of the flute. Organisational learning occurs through the handing back and forth, and the evaluation, of the flute sections. This process involves a kinaesthetic and aesthetic dimension in as much as flute makers, both individually and collectively, make judgements of hand and eye (Yanow, 2000). Thus, while knowledge is undoubtedly replicated, it draws on a tacit and embodied appreciation of the feel of the flute at various stages in the production process that is vital in ensuring the quality of the final product. Novice and experienced flute makers must compare the feel of the artefact that they are producing; knowledge and learning develops from a collective shared tacit understanding of what constitutes the distinctive feel of the company's flute.

The significance of the (kin)aesthetic dimension in craft knowledge is also evident in Strati's (1999) detailed study of workmen in the construction sector. Strati describes how workmen on a roof learn to feel the roof through their feet. The workmen have a kinaesthetic understanding of how to work safely on a roof, an understanding in which feeling, understanding, and knowing intermesh to underpin routine activity as well as new inventions (Gherardi, 2006, p. 81). Such work does not exclude codified knowledge; Work by Gherardi and Nicolini (2002, 2003) of how knowledge about safety is acquired in the construction sector shows how inter-personal familiarity and trust circulating in teams, (kin)aesthetic awareness, and norms which arise not only from practice but also industry-wide regulations, all combine in the replication and renewal of craft knowledge.

From this brief review two aspects of the knowledge process can be highlighted. Firstly, the craft/task based activities are primarily concerned with replicating and preserving existing knowledge to produce a product or service. The production of radically new knowledge is not of central concern. However, over a relatively stable period, the knowledge developed through everyday interaction among people involved in the same tasks, or between masters and apprentices, is far from mundane or unchanging. It evolves constantly in response to the changing environment, customer requirements, and evolving community practices, and is also capable of quite significant innovations which, however, stop short of path-breaking leaps. The innovations are of an incremental nature, but always geared towards the production of a customised product marked by artistic signature and craft awareness of some form. Thus, while craft/task based activities may be concerned with preserving existing knowledge, this does not in any way mean that they are open to substitution or replication by new actors. Experience, embodied know-how, continuous learning, and (kin)aesthetic awareness are some of the factors responsible for a form of unique knowledge that requires special cultivation.

Secondly, in craft/task based activities the social dynamic sustaining knowledge is characterised by work colleagues sharing a community-specific language, relating stories, building strong ties of reciprocity, trust, and dependence, drawing on facial, tactile, and emotional contact. All of which lead to a high degree of mutuality borne out of shared work. While knowledge can be, and is, codified to facilitate its transfer, as in the case of Xerox manuals, the preferred mode of knowledge transfer is through verbal and physical communication. This involves the development of a particular language, including physical cues through which knowledge and understanding is shared. For instance, the quality of a flute results from the fine degrees of dimension and tolerance in how the components fit and function as a whole (Cook and Brown, 1999). Yet such dimensions and tolerance are not known explicitly by the flute makers, who prefer hand-eye judgements to those available through the use of measuring instruments such as callipers and feeler gauges.

Newcomers to such craft/task based communities must engage in a period of apprenticeship before they are able to fully participate in the activities of the community. Knowledge of how to become a midwife, tailor, or flute maker is acquired through the practice of engagement in a relatively close-knit community which, in the course of time, produces forms of affiliation that knit together objects, people, and ways of doing things. The result is strong community ties structured around particular ways of doing things, resulting in cultures of work and professional identity that can frequently clash with standards elsewhere, even in the same organisation. For instance, Xerox technicians privileging community knowledge over that provided in organisational manuals (Orr, 1996), or construction workers who seek employment only in those building businesses that have safety standards that are congruent with those aquired in their safety practice communities (Gherardi, 2006).

Professional Communities

To engage in formal professional practices such as accountancy, architecture, law, and medicine, individuals are required to undertake a prolonged period of education and training, to obtain officially accredited qualifications, and to be bound by a professional body's code of ethics. By gaining membership of a profession, individuals usually gain access to high levels of remuneration and social status. However a much wider range of occupations than those listed above, including, for instance, advertising, consulting, education, and nursing, have come to be termed professions. As Empson (2007) notes '[t]he fact that that such a diverse range of occupations can be grouped together reflects the extremely fluid definitional boundaries of the term'.

Moreover, the development of sophisticated IT-based knowledge-management systems within large professional organisations since the 1990s has fundamentally changed the nature of professional expertise. With the aid of such systems increasing areas of professional work can be performed by less highly educated and lower paid paraprofessionals or outsourced to lower wage countries. Communities of practice are among the knowledge management techniques currently being promoted and adopted in a variety of professional activities. The need to improve efficiency and quality, and reduce costs, against a background of creeping privatisation and market competition is driving this trend in public sector professional activities. For instance private sector knowledge management concepts and practices are thought to hold potential for the development of quality improvement initiatives and the reform of healthcare systems (Bates and Robert, 2002).[5] According to Snyder and Wenger (2003), the unprecedented challenges faced by the public sector today, including greater consumer scrutiny, require an increased capability for learning, innovation and coordination that is hampered by current organisational structures. For example, they contend that large public bureaucracies are ill-equipped to address problems that are too complex to predict or standardise, and which are better suited to more agile, knowledge-based, boundary-spanning structures such as CoPs. They suggest that CoPs that cross formal boundaries can bring together practitioners facing common challenges to learn from each other, to

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[5] Across the health sector, new initiatives which focus on interaction, collaboration and increased sharing of information and knowledge are being developed, driven by a number of pressures, ranging from the growing healthcare needs of an increasingly aged population and growing expectations of improved treatment brought about by technological developments, to the rapid world-wide spread of diseases. The sharing of medical knowledge is deemed essential in these circumstances. Accordingly, in 2003, the World Health Organisation established a department for knowledge management and sharing with the mission of bridging the know-do gap: the gap between what is known and what is done, which is considered to underpin most health inequities in the world. See: http://www.who.int/kms/about/units/en/index.html. At the national level the UK health system, for instance, is committed to the development of a national network to share clinical and patient information. Various technology based initiatives are in place to encourage knowledge sharing, including a toolkit for the establishment of CoPs, in order to ensure that information exchange can lead to genuine knowledge-development through collaboration. See for instance: http://www.nelh.nhs.uk/knowledge_management/default.asp), and http://www.nelh.nhs.uk/knowledge_management/km2/cop_toolkit.asp

develop new solutions to problems, to find synergies across organisations, and to coordinate efforts[6]. Sparked by such claims, professionals in the healthcare and education sectors have received a lot of attention from researchers interested in communities of practice.[7] The evidence from this body of research reveals a number of characteristics that are common to professional communities.

The first of these relates to the type of knowledge acquired, generated, and disseminated by professionals. The development of professional competences requires mastery of a body of both tacit and codified knowledge. While much of the codified knowledge can be acquired through individual academic study, tacit knowledge must be gained through learning by doing. The significance of access to tacit knowledge through group practice is highlighted by Gabbay and le May (2005) in their ethnographic study of how primary care clinicians derive their individual and collective healthcare decisions. They find that these clinicians work in informal CoPs, combining information from a wide range of sources into 'mindlines' (internalised and collectively reinforced tacit guidelines) which they use to inform their practice, and rarely access or use explicit sources directly. But how is such knowledge gained, held, and communicated? In a study of pre-operative anaesthetic work in a British hospital, Hindmarsh and Pilnick, (2002) find that the organising practices and skills associated with *in-situ* team-working reveal the critical importance of embodied conduct. Rather like craft communities, practice includes all the implicit relations, tacit conventions, subtle cues, untold rules of thumb, recognisable intuitions, specific perceptions, well-tuned sensitivities, embodied understandings, underlying assumptions, and shared world views. Such practice-based knowledge is acquired through social interaction involving verbal communication through CoP-specific language, the use of artefacts, and, perhaps to a lesser extent but important in some professional activities, the acquisition of embodied conduct through the observation and imitation of the actions of experts.

The formal knowledge-base of a profession is usually well established. To become an accepted member of a profession, individuals must acquire specific qualifications as well as knowledge gained through practice-based learning. The extent of the formal knowledge required by individuals engaging in professional activities is much greater than that required by craft and task-based activities. For instance, while the construction workers studied by Gherardi (2006) do acquire knowledge through class-based learning, this is of a much smaller significance to their ability to participate in a community of workers on a building site than that required for a doctor to function in a hospital environment.

Embodied professional competences are learned through the imitation and repetition of bodily tasks and through this, as in craft based activities, the

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[6] Wenger and Snyder suggest that evidence of such good practice already exists in US government departments. To demonstrate this they describe four CoPs in the US federal government, which bring together practitioners within and across agencies, as well as across government levels: the first is the Rumble Strip community, which has spurred the widespread adoption of highway safety devices that have saved lives and taxpayer money; secondly, the E-Regulation community, which has accelerated the implementation of a cross-agency efforts to reduce paperwork; thirdly, SafeCities, which has created new partnerships across a range of disciplines to reduce gun violence on the streets; and fourth, the CompanyCommand, which has helped US Army company commanders take on the challenges of leadership

[7] Studies on CoPs in healthcare range from those exploring the learning and knowledge creating activities of a range of actors in the sector from patients learning to cope with serious illness (Roos, 2003; Josefsson, 2005), to the induction of doctors into the medical profession through practice and the ongoing development of their knowledge (Bleakley, 2002; Gabbay and le May, 2005; Goodwin et al., 2005 inter alia.). It is the latter area of research that is of relevance to our discussion. Within the field of education it is no surprise to find a wide body of interest in CoPs, given its origins in situated learning theory (Anning, 2002; Cave, 2004 McConnell, 2005; Shay, 2005; Fruchter and Lewis, 2003; inter alia.). Some studies focus on the professional development of teachers, from students learning to become teachers, to in-service professional development, and experiments to improve teaching practice (see for example: Eick and Dias, 2005; Sutherland, Scanlon and Sperring, 2004; Barab, Squire and Dueber, 2000; Knight, 2002). Other studies have explored how academics learn to become researchers (see for example, Herzig, 2004; Dison, 2004).

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development of a (kin)aesthetic understanding. For instance, a successful surgeon must learn to feel the correct pressure with which to use a scalpel in order to make an incision of the required depth in the same way that a flute maker must learn the correct feel of an appropriately calibrated flute. However, the embodied competences of professionals like doctors and teachers also includes those necessary to project an image of authority and confidence for patients and students to accept the declarative knowledge upon which the activities of such professionals often depend. Part of their embodied conduct is then a performance necessary to satisfy the needs of their audience. In professional activities performance knowledge is used in a reflexive manner. While other embodied knowledge, such as that in craft activities, is deeply embedded in the individual and used in a non-reflexive manner.

The material and technologically-embodied nature of knowledge is also important in professional communities. Professionals use a range tools in the performance of their work, from sophisticated medical instruments to libraries and electronic databases. This is particularly evident in the practice of medicine where Tellioglu (2003), drawing on several ethnographic studies carried out in radiology departments, and on the assessment of computer systems and artefacts used to support communication, coordination, and collaboration in radiographic healthcare, finds that coordination between CoPs is established through interactions between them by using artefacts from object worlds and with interactions of different kinds, such as for action, possibilities, clarification, and orientation. Yet the role of technology in facilitating interactions may be limited. For instance, in their ethnographic study of knowledge flows between various professional groups working in a radiation oncology unit in an Italian hospital, Tagliaventi and Mattarelli (2006) found that, despite the high tech environment, operational proximity in combination with value sharing acted as a leveraging tool for practice-sharing.

The nature of social interaction provides a second common characteristic of professional communities. The apprenticeship-style learning necessary for the development of professional competences involves the co-location of a newcomer with experienced members of a CoP. Newcomers absorb knowledge through social interaction with, and observation of the practices of, other members of the community. In this way novices progress from legitimate peripheral participation towards full participation; shaping knowledge, developing their professional identities, and participating in incremental innovative activity as they learn. A number of empirical studies reveal the importance of legitimate peripheral participation in the development of pre-service teachers (Sutherland, Scanlon and Sperring, 2004; Eick and Dias, 2005) as well as medical practices (Goodwin et al., 2005). Legitimate peripheral participants have a vital role in any community – they do more than merely absorb knowledge. For instance, Bleakley (2002) examined the pre-registration house officer (PRHO) year, which can be seen as a formal apprenticeship into the profession of medicine, finding that PRHOs may actively co-construct knowledge with experts, offering potential transformation of the practices. In this sense, in professional communities, meaning is negotiated through interactions between all members.

Professional identity develops through social interactions with a variety of community members. For instance, Herzig (2004) suggests that participation in relevant CoPs can provide the academic and social integration that is critical for persevering in doctoral research. An important aspect of integration into academic CoPs is the formation of the identity of the doctoral student as an academic researcher (Dison, 2004). As the evidence underlines, learning in a professional CoP is as much about social interaction between peripheral participants as it is about a relationship between an expert and a novice. The knowledge-base and identity of

professionals is developed through informal exchanges with colleagues as much as it is through the formal process of supervision by an expert.

Once individuals have mastered a body of codified and practice-based professional knowledge, they can benefit from knowledge exchanges through virtual communications with geographically dispersed members of their profession. The authenticity of knowledge circulating in virtual communications networks is ensured by the presence of both formal and informal professional standards of behaviour. Knowledge exchange in an informal evidence-based healthcare email network of 2,800 UK healthcare practitioners investigated by Russell, Greenhalgh, Boynton and Rigby (2004) found that the network helped to bridge the gap between research and practice by serving as a rich source of information, providing access to members' experiences, suggestions, and ideas, facilitating cross boundary collaboration, and enabling participation in networking at a variety of levels. In addition, *ad hoc* groupings emerged spontaneously as members discovered common areas of interest. This study illuminates not only the value of virtual communication, but also the importance of informal social processes for the widespread dissemination of knowledge for evidence based healthcare.[8]

Virtual communication in education and academic research has also received much attention (Hodgson, Perriton and Reynolds, 2005; Kling and Courtright, 2003; Schlager and Fusco, 2003; Voogt, Almekinders, van den Akker and Moonen, 2005). As Tomlinson's (2002) study of the scientific community of mainly researchers within the discipline of robotics illustrates that geographically distributed CoPs can be supported by virtual communication alongside the mobility of key individuals. Evidence from the use of virtual communications suggests that, while strong social social ties are important in the acquisition of professional skills, once professional status is reached individuals can also acquire knowledge through weak social ties facilitated through virtual and distributed networks.

Indeed informal CoPs, whether virtual or face-to-face, can be important in sustaining and building practice, as illustrated in relation to the development research students (Adams and Freeman, 2000; Janson, Howard and Schoenberger-Ograd, 2004). Importantly, as an investigation of the communities supported by the UK charity Macmillan Cancer Relief reveals, informal communities are longer-lived than formal connections (Donaldson, Lank and Maher, 2004; 2005). Moreover, the charity was able to mobilise the support of the informal CoPs to influence healthcare policy and practice. In this sense CoPs can be seen as a force for change.

The nature of innovation, which tends to be incremental and concerned with improving service quality rather than radical, is the third common characteristic of professional communities. Among the professional CoPs reviewed creative activity was stimulated by contact with other CoPs, therefore one might expect innovation to be promoted by contact with distributed CoPs, whether or not this is achieved through virtual communication or through the mobility of individuals. Lathlean and Le May (2002) explore CoPs as a mechanism for interagency working between groups of multi-professionals in primary care and out patient departments. In this context CoPs are seen as a useful mechanism for the development of services that span different professional perspectives and involve consumer interests. Bridging the boundaries between different groups within the healthcare system is essential for the efficient exchange of information and for the dissemination of innovation because, as a qualitative study tracing 8 innovations in the UK healthcare sector revealed, the

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[8] Critical success factors include a broad based membership from both the research and service communities; a loose and fluid network structure; right targeting of messages based on members' interests; the presence of a strong network identity and culture of reciprocity; and the opportunity for new members to learn through passive participation.

uni-disciplinary CoPs of different professions retard the spread of innovations (Ferlie et al., 2005). Multi-professional organisations and interactions between CoPs can, then, assist in the dissemination of innovative practices. Similarly, Gabbay, le May, Jefferson, Webb, Lovelock, Powell, and Lathlean, (2003) report a study that facilitated and evaluated two multi-agency CoPs working on improving specific aspects of health and social services for older people, and analysed how they processed and applied knowledge in formulating their views.[9]

Studies on collaborative research in education show how CoPs can facilitate incremental innovations in teaching practices (Bruce and Easley, 2000; Hodkinson 2004; Linington and Excell 2004). For instance, Bruce and Easley (2000) trace the experience of 'Dialogues in Methods of Education' (DIME), a group of school and university staff who study together to improve their own teaching practice through joint research and sharing ideas. Their study reveals the importance of accommodating difference and providing mutual support to sustain long term collaboration. As Hodkinson (2004) notes, educational research occurs in a field made up of overlapping CoPs with largely unwritten and continually changing rules.

These studies indicate that efforts to innovate involving interactions between CoPs give rise to greater diversity and, therefore, a wider range of possible outcomes than innovation within a single CoP. Interaction with other professional or non-professional groups is widespread. For instance, the healthcare sector is made up of a diverse range of professional groups, including accountants, managers, doctors, nurses, radiologists, dieticians, pharmacists, and therapists of various sorts. In addition, many agencies and groups interact with healthcare professionals and their organisations, including social services, health visitors, voluntary organisations, pharmaceutical companies and medical instrument suppliers, as well as patients and their families. Not surprisingly, then, many CoP studies in healthcare explore the boundaries and interactions between these various groups, with their often distinctive cultures (Ferlie et al., 2005; Lathlean and Le May, 2002; Kernick, 2005; Gabbay, le May, Jefferson, Webb, Lovelock, Powell, Lathlean, 2003; Tellioglu, 2003) while others consider the various CoPs that patients come into contact with during their treatment. For instance, Freed (1999) uses the CoPs framework to analyse women's pregnancy stories, finding that the operative CoPs in the lives of these women are the communities comprised of doctors, health professionals, family members, and so on, all of whom have specific opinions about pregnancy. While pregnant women do not constitute a CoP themselves, their stories provide data on the intersection and collision of disparate CoPs. In a sense, pregnant women, like other patients, can act as boundary processes, including boundary objects, facilitating knowledge exchange between different yet related CoPs in the healthcare sector.

In education the value of formal boundary processes, such as courses and workshops designed to promote continuing professional development, is open to question (Knight, 2002). Research suggests that explicitly stated, often codified, pedagogic knowledge promoted by such events and systems of formal certification, lacks the depth of tacit knowledge gained in practice (Burroughs, Schwartz and Hendricks-Lee, 2000). Studies linking the initial training of teachers to the professional development of existing teachers provide further insight into the potential of boundary processes. Barab, Squire and Dueber (2000), for example, explore a partnership between two universities and eight surrounding schools supporting a learning community of pre-service and practicing teachers. They explore how asynchronous conferencing tools are used to facilitate communication across

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[9] Four themes emerged from their data: 1) the way that certain kinds of knowledge became privileged and accepted; 2) the ways in which the CoP members transformed and internalised new knowledge; 3) how the haphazard processing of the available knowledge was contingent upon the organisational features of the groups; and 4) the ways in which the changing agendas, roles and power-relations had differential effects on collective sense making.

geographic and chronological boundaries, making possible a learning environment relevant to both pre-service and in-service teachers. It is then important to note the role of humans and non-human actors in acting as boundary processes through which interaction between CoPs can occur.

A fourth feature of professional communities is that their very existence can act as a barrier to radical change. The protectionist role played by professional associations can have a detrimental impact on innovation by privileging the accepted body of knowledge and resisting the adoption of knowledge and practices. While incremental innovations may be taken up in individual communities, for their widespread adoption by the meta-community of the profession they must build on existing knowledge and support the status quo. The rigidities displayed by professional groups is illustrated by Bullough, et al., (2004), who use the CoPs framework to describe how clinical and university-based educators share a set of assumptions about their respective roles - described as a form of "collusion"- that confirm status differences as well as the value of transmissive models of teaching. In this case, CoPs undermine the goal of collaboration and therefore require that attention be given not only to the administrative and motivational problem involved in forming university/school partnerships, but also to questions of identity formation and relationship building. In this way professional boundaries can act as barriers to knowledge sharing (Bates, 2000; Currie and Suhomlinova, 2006).

While resistant to radical change, CoPs in professional activities are, nevertheless a valuable mechanism through which new knowledge can be disseminated. For instance, Rosenheck (2001) suggests that organisational processes, such as the development of self-sustaining CoPs, as well as learning organisations can have an important impact on the introduction of innovative treatments into practice. Similarly, Faulconbridge's (2007) study of collective learning in advertising and law reveals that professional associations can play an important role encouraging the formation of inter-firm CoPs and the consequent dissemination of knowledge across the sector.

Finally, several studies of health and education professions explore the issue of alignment between CoPs and the individual and the organisational contexts within which they reside, finding that CoPs can help to ameliorate dissonances between professions and organisations (see, for example: Hodkinson and Hodkinson, 2004; Adams and Blandford, 2005). For instance, following their investigation of the introduction of new privacy and security policies in two hospitals, Adams and Blandford (2005) found CoPs to be a valuable mechanism for overcoming the difficulties arising from the implementation of policies developed by the formal organisational structure without adequate regard to their impact on the everyday practices of those delivering healthcare service. In the hospitals studied, CoPs helped to bridge the gap between the organisation and user perspective. On the other hand, CoPs can also be a source of dissonance between professionals and organisations because the identity of the professional is often more firmly anchored to the professional CoP rather than the organisation within which they are employed. Tensions between professional CoPs can surface when disagreements arise between, for instance, professional standards and an organisation's strategy. Yet in such circumstances the rhetoric of CoPs can be employed to resolve conflicts. For example, in a study of the adoption of a radical innovation in the treatment of prostate cancer Swan et al. (2002) trace the use of CoPs as a rhetorical device to counter resistance from powerful professional groups in order to mobilise and legitimise changes in the work practices. CoPs can, in this way, be employed to deal with dissonance between organisational strategies and professional practices.

The professional activities reviewed above are usually situated within large hierarchical organisational structures such as hospitals, schools, and universities, which in many developed countries are part of a national system of public provision.

Such contexts undoubtedly influence the extent to which these professions are able to act independently of their organisational context. However, while all professionals require expert academic and practitioner training not all of them will work within a large organisation. Indeed many, such as, accountants, lawyers, and architects, may work in individual or small peer managed practices. Professionals practicing in such organisational contexts will have a greater degree of self-determination, and the alignment of professional interests with organisational aims will be less problematic. Even so, all formal professions are to some extent constrained by professional organisations and/or government regulation[10]; conditions that will impinge on the evolution of practices in such areas.

A number of issues emerge from the research on professional communities reviewed in this section. The first of these relates to the type of knowledge acquired, generated, and disseminated by professional communities. As we have seen this includes codified, tacit and embodied knowledge acquired through social interacton as well as engagement with the material world. The second issue relates to the type of social interaction, as in the task/craft based activities considered earlier; this is facilitated through CoP-specific language, the use of artefacts, and, perhaps to a lesser extent, but important in some professional activities, the demonstration and imitation of embodied conduct involving aesthetic and kinaesthetic dimensions. But once individuals have mastered a body of professional practice-based knowledge, they can benefit from knowledge exchanges through virtual communications with geographically dispersed members of their profession. Third, innovation and creativity appear to be stronger where professional communities intersect with related CoPs. Fourth, professional communities are constrained by the regulatory activities of professional associations, a factor that certainly has an important impact on the ongoing development of accepted practices. Finally, the fact that professional communities extend beyond the boundaries of the organisations in which they practice has important implications for the management of professionals.

Expert Communities

In this section we examine the ecologies of highly creative expert communities, organised in some shape or form to broker new knowledge of a path-breaking or path-bending nature. Distinguishing such communities is not straightforward for at least three reasons. Firstly, many high-creativity communities are not communities but project-based coalitions assembled together for short periods and then disbanded (Grabher, 2004). Secondly, there is no clear cut boundary between incremental and radical innovation or between exploratory and exploitative knowledge: routines or small discoveries can stack up to produce new breakthroughs, and accidental combinations could spark radical novelty. Thirdly, there is no clear understanding of what should be included in this type of community. The category of creative/expert community therefore yields no obvious or clearly demarcated group.

Yet there is something distinctive about this category of knowledge activity. What we have in mind is an ecology of knowledge that combines expert knowledge with high levels of creativity, that tends to be characterised by relatively fluid organisational associations and considerable actor autonomy or cache, and that frequently involves high-energy peer interactions structured around project-based work. This ecology can be firm-specific, as in the case of product-development teams in individual organisations which might be located in a single site or are

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[10] For instance, following a series of corporate failures in 2001, including the Enron debacle, the US government passed the Sarbanes-Oxley Act of 2002, one provision of which being to limit the non-audit client activities of accountancy firms. Given the rapid growth of that consulting activities of the large accountancy firms since the 1980s this legistation has had a significant impact on accountancy organisations and the scope of practice for professional accountants.

dispersed, it can be organised as a network, as in the case of scientific, artistic or academic communities that might gather around specific projects, or it can be an inter-organisational ecology, as in the case of business or advertising consultants working closely with clients in different firms. However, in all cases, the high autonomy, expertise, and connectivity of participants tends to yield associations and working practices that spill over organisational boundaries. Typical actors in this ecology of knowledge are scientists, product developers, academics, visual and performing artists, advertisers, software developers, consultants, media professionals, and designers, rather than other creative groups, such as artisans, technicians, engineers, and professionals, more tightly tied into workplace routines and routine work.

The creative expert ecology thrives on difference, more accurately, on the juxtaposition of variety. An essential spark in expert networks and teams working on new or complex problems is the combination of not only complementary skills and competences but also diverse perspectives and capabilities. Novelty is the result of fusing elements not connected before, of learning based on heteronymous interactions that include consensus and disagreement, and of willingness to experiment and venture into uncharted territory (Lindkvist, 2005). The key seems to be the mobilisation of difference in uncertain circumstances as a means of generating new interactive knowledge. The ambiguities of heterogeneity – managed through particular forms of interaction and alignment - are the stimulus of new knowledge pathways. This appears to be a common feature of different types of high creativity community, be they traders on a New York financial derivatives floor (Beunza and Stark, 2004), or scientists based in, or visiting, renowned laboratories (Knorr Cetina, 1999; Collins, 2001). It is common to corporations relying upon innovation units composed of multidisciplinary teams and blue-sky scenario-building or project-based teams composed of experts from different sites as well as external advisers and consultants. Similarly, according to Creplet et al (2001) there is a clear difference between business consultants who apply acquired knowledge to new situations and business experts who 'create new knowledge that was not existing before' (p. 1521) through their ability to engage confidently with a variety of peers and clients as well as fashion progress out of ambivalent, complex and uncertain environments. In global advertising, the mobilisation of cognitive distance, improvisation, frequent personnel changes, and varying client links, seems to define the creative cutting edge (Grabher, 2004), increasingly resembling the 'structured chaos' – the fine balance between free improvisation and known rules of engagement – that drives experimentalism in the visual and performing arts (Yanow, 2001).

The mobilisation and management of creativity in expert communities, crucially, is a matter of endorsement and alignment. These are communities in which experts come with substantial egos, expectations from collaboration are high, turnover is frequent, rules and procedures are rudimentary, deadlines are often tight, ambiguity and uncertainty abound, and all but the broad objectives are ill defined. Their success is far from guaranteed, given the immense scope there is for misalignment, misunderstanding and disunity. Indeed, the threat of failure or of small achievement only always looms large. The evidence on communities that do succeed in generating new exploratory knowledge through collaboration, however, reveals the significance of four sets of factors in helping the ambiguities of heterogeneity to convert into new creative openings.

The first set relates to the psychology of disclosure and peer recognition among creative experts. Lars Lindkvist (2005: 1203) has suggested that their collaborations 'tell more than we can know' (to contrast to Michael Polanyi's classical formulation of tacit knowledge networks as those that 'know more than we can tell'). At the centre,

according to Lindkvist, lie the problem-solving and expert free agents offering bundles of articulate knowledge (in contrast to the individuals in communities of practice, who learn through doing, socialisation, and group enculturation). These individuals possess considerable autonomy and power derived from their unique skills and experience. They know that they can work a certain magic. However, they are also inclined to hone and refine their capabilities for future advantage, to gain peer affirmation and test new ground through collaboration with knowledgeable others, and to get drawn into challenging problem-solving or problem-visualising projects. Their clear sense of self-worth and esteem overlaps with a commitment to joint venture motivated by inquisitiveness and interest, reward and satisfaction, goal orientation, or corporate and ethical responsibility. According to Creplet et al (2001) in their study of expert consultants, these impulses coincide with certain personality traits, which include charisma, command, empathy, and logical capability. Without such traits, the trust placed on experts to address complex tasks in collaborative networks would falter, but it is worth noting that the traits form part of the professional identity and reputation of the experts, inseparable from their skills and competences and consciously or tacitly cultivated by the experts.

Secondly, however, a particular form of professional integrity lies at the centre of the creative process in exploratory teams. The experts are involved in tasks that require collaborative effort of a certain kind. It is commonly argued by researchers working on high creativity expert communities that they are not communitarian but epistemic in their collaborative dynamic, characterised by strong loyalties to problem scenarios than those rooted in inter-personal ties. This is an important distinction, one that helps also to differentiate among seemingly similar expert communities. For example, Gernot Grabher (2004; Grabher and Ibert, 2005) has found that even in software, some collaborative ventures rely on repeating or recombining expert knowledge between projects, with teams characterised by lasting and intense social ties, common work histories, and high levels of trust. In contrast, in high-creativity collaborative projects in the London and Munich advertising industries, he observes a dynamic based on maintaining cognitive distance in teams characterised by intense but ephemeral and impersonal ties held together by professional reputation, peer recognition, and socialisation into a particular work and professional culture. The willingness to participate is the product of a strong professional ethic. The weak ties yield a creativity linked to studied/calculated loyalty and to learning acquired from a plural web of association that is actively maintained. It is the ethos of 'learning by switching' between teams, agencies, supplier and clients that prevails, 'driven by the canonical compulsion of freshness, mobility, and flexibility' (Grabher and Ibert, 2006: 261). Significantly, for Grabher, this sociology of weak ties is less an incentive for exit – unless the project and its team lose focus and appeal – than a stimulus for voice and engagement in a joint venture.

Thirdly, however, enthusiastic participation is not guaranteed by strong project and professional loyalties alone, but is also influenced by the culture of the interactive milieu, with factors such as the scope for free thinking, imaginative play, problem visualisation, hanging out, and minimal formality, hierarchy, and bureaucracy, deemed to be important in the available literature. For example, Mark Thompson (2005), in his ethnography of a high-energy web design project team, describes a conversational culture marked by impromptu meetings, informality, many interruptions, no agenda, rapid analysis of problems, and rapid absorption of points and alternatives. He also notes the 'consciously cultivated informality' (p. 156), supported by a T-shirt, skate-board and bean-bag culture, under-girded by dedicated provision of 'pool tables (which were in use continuously while I was present), and table-football, extensive informal meeting areas, and a plethora of company sponsored toys, from video games to plastic weapons' (p. 156). These are considered as stimuli for collective experimentation and free thinking, sometimes

deliberately encouraged through 'non-techie' experiments, such as competitions to produce a portrait of another group member or to design a front end for an MP3 player. While the specific nature of sociality is bound to vary from one gathering of creative experts to another, it seems that factors such as informality, iterative purposefulness, and engineering productive idleness, are common to most situations. They tend to recur among teams of academics or scientists, corporate R&D teams working to a stricter specification and deadline, or a group of artistic directors who have come together for the first time to put together a novel programme of performances. They are the spark of improvisation, without which the creative energies necessary for radical inventiveness would not be unlocked (Grabher, 2004; Hatch, 1999; Yanow, 2001).

The interactive milieu of high-creativity communities has an important spatial dimension. Commentators on creative industries frequently remark on the role of urban centres in providing specialised know-how and services, contact networks and opportunities (Leadbeater, 1999), possibilities to track and test the market (Maskell, 2004), and the buzz, vitality and cultural inventiveness that the creative classes require (Storper and Venables, 2002; Florida, 2002). Much of what is new in the cultural economy is generated or sustained through urban performances of one kind or another (Amin with Thrift, 2006). An interesting question, though, is whether these urban characteristics can be summarised as an interactive ecology allowing exploitation of the strength of weak ties. The buzz, meeting places, multiple inputs, varied contacts, talk and opinion, that certain urban centres provide act as a 'spill-over' interactive milieu that nourishes as well as supports the weak ties that characterise high-energy project teams. The sociality of weak ties that characterises the expert teams we have been discussing is nourished by the variety, serendipity, and possibility offered by the urban environment. As Grabher (2004) notes, an intrinsic component of the interactive space of Soho or Munich advertising teams are the local bolt-holes, meeting places and social networks that individuals rely upon to conduct business and explore new possibilities[11].

In the end, though, if the challenge of managing highly autonomous experts is rather like that of herding cats, without alignment and common orientation within project teams, then the link between creativity and tangible innovations is broken. This brings us to the fourth and last set of factors that we consider to be significant in ensuring that the ambiguities of heterogeneity convert into new openings. Much has been written about the role of intermediaries of various kinds in communities of practice, and it seems that they are especially central for expert communities in which the scope for top-down management as well as bottom-up cohesion is limited for the reasons already discussed. Although common orientation to a joint project, gradually depositing a division of labour among experts with different capabilities, is clearly an important integrating device, it is not sufficient to channel the varied creative energies towards a common endeavour. Many complimentary mechanisms of alignment seem to be in play, forming an intricate architecture for managing creative dissonance.

One of these modes is codification. Nonaka and Takeuchi (1995), and more recently others working on epistemic communities (e.g. Creplet et al., 2001), have argued that the codification of tacit knowledge is crucial for circulating know-how in the creative process. Making idiosyncratic or pre-cognitive knowledge explicit is not only essential for capturing and circulating know-how, as Nonaka has stressed, but is part of the process by which collective sense-making occurs. It allows different

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[11] In making this point, we are not arguing that the most creative teams are those located in the right kind of urban environment (since creative ecologies come in varied organisational and spatial forms that involve different sociologies of interaction), but that in explaining the link between cities and economic creativity, there may be some merit in seeing the urban as an element of a sociality of weak ties.

actors - proximate and distant - to communicate with each other but, most importantly, in project-based work with pressing deadlines, it herds interlocutors in a certain direction, as they come to internalise and share the codified objects. This is one important achievement gathered around exchanges of scribbles, drawings, formulae, data, briefings, and reports. Fischer (2001) notes, for example, how an urban-planning experiment that tried to bring different communities of interest together was enhanced by an interactive electronic table that allowed people to jointly design and visualise an urban layout. Similarly, Carlile (2002) refers to the integrating role of shared artefacts and technologies in helping a heterogeneously composed design engineering team to produce a working prototype[12].

Another mode of alignment in non-hierarchical expert teams might be labelled meta-coding. High creativity expert teams see themselves as autonomous, yet they possess a discipline that is not entirely hermeneutic or reducible to self-government. Work is now starting to emerge on tools of meta-governance that are not obviously hierarchical. For example, Hernández-Martí (2005), with long experience in organising innovation through CoPs in a leading oilfield services company, describes how the establishment of meta-teams composed of 'visionaries' from diverse backgrounds in the company has helped to align different expert communities (e.g. through their role in multi-team conferences). In contrast, Kogut and Macpherson (2004) show how Chicago School ideas on privatisation have spread as a global standard among practising economists around the world through the circulation of graduates, citations, and other metrics, all working as a meta-code of measure for otherwise fiercely autonomous policy experts. The potential of meta-codes and other tools of alignment to succeed, of course, cannot be taken for granted. A considerable degree of imagination and effort is required - at times without success, if cognitive distances remain irreconcilable. Rist, Zimermann and Wiesmann (2004) have shown, for example, that in some collaborative experiments between different knowledge stakeholders in 'development' research, where there are strong differences over 'the nature of mind and matter' (p. 14), the scope for alignment is weak. The authors contrast the productive engagement between scientists and indigenous epistemic communities in areas such as healing and medicinal science or organic farming, where foundational beliefs about the nature of matter have been dislodged, with the situation in areas of mainstream science, where experts wedded to canonical beliefs and established methodologies, were unable to overcome their suspicion of the world views and practices of indigenous peoples. The paradigmatic dimensions of what counts as knowledge in different disciplines, thus, cannot be underestimated in accounting for what is and is not possible in making more our of dissonance.

In this section, we have focused on the challenges of interaction and alignment in creative communities of experts. This is because we believe that in such communities, there is no obvious source of cohesion and mutuality. The projects are short-lived, the individuals are not spontaneously collective, tasks are not shared, professional identities are not shaped through joint work, and strong loyalties to others in the community are not prevalent. Instead, autonomy, improvisation, individual expertise, and high bursts of energy are prime characteristics. The tools of collaboration have to be made, but when they are successfully in place, the potential for experimentation, leading to step-change innovations, seems to be immense. Our reading of the literature suggests that factors such as professional integrity and bench-marking, an ecology of weak ties, objects of transversal alignment and

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[12] The language of codification might even be extended to include styles of chit-chat, informal address, bodily expression and visual culture that emerge as a code of group conduct, as we have seen above in the example of soft-ball throwing web designers.

inculation, and arranging for improvisation, form part of the interactive and governance architecture of successful innovation in expert communities.

From Virtualism to Virtual Communities

As it becomes easier to communicate with distant others in real time and in increasingly rich ways due to the rise of sophisticated electronic and satellite technologies, research interest is growing in how such interaction contributes to knowledge generation. This interest has been fuelled by the proliferation of online communities of one sort or another. A central question is whether these can be classed as learning communities and if so how they differ from communities that depend on social familiarity and direct engagement. Before exploring this question in relation to the dynamics of online communities, we examine the implications of the growing use of virtual technologies by non-virtual communities. We start with the latter for two reasons. Firstly, we wish to address the commonly held view that the quality of knowledge generation in spatially proximate communities is superior to that associated with distanciated interactions. We will argue that virtual technologies are increasingly folding the two spaces into one continuum with differing nodal local intensities. Secondly, we wish to benchmark the discussion that follows relating to online communities, by asking if there might be enough common ground between the two modes of virtual organisation to warrant some re-thinking of the idea that online communities are radically different in their knowledge generation dynamics.

Going Virtual

While the pioneers of the idea of learning in communities of practice – Lave and Wenger, Orr, Duguid and Seely Brown – were keen to show that knowledge is generated through embedded social practices and cultures of identification within small communities that share a task, problem or project, they were far from insensitive to the connections between these communities and the rest of the organisation. It is fair to say, however, that despite this awareness, they chose to explain situated learning in terms of daily interactions between members of a co-located community. This tendency to see the space of community to be the space of the familiarly nearby is beginning to change among some of the pioneers as well among a new generation of researchers stimulated by the rapid growth of virtual communications. Wenger, for example, has explored the increasing use of new internet tools and other virtual technologies by spatially dispersed communities and by those who mostly meet face-to-face (Wenger et. al., 2005). The conclusion he reaches is that although 'communities reach out across much greater distances than ever before', participation within them has become 'richer' and 'more meaningful despite limited "face time"' (p. 1). For Wenger the 'crucial role of technology … is to provide new resources for making togetherness more continuous in spite of separation in time and space', with the help of 'new breeds of interfaces and devices that bring the experience of community to the individual' (p. 2).

Technology, for Wenger is not antithetical, but complementary to community, if properly designed and properly managed. For example, he speaks of good technology stewardship, to ensure that the expanding range of tools, including those facilitating synchronous interaction (e.g. instant messaging, telephony, whiteboard, slide and video links), asynchronous interaction (e.g. email, discussion boards, email lists, wikis and blogs), and access to stored information (e.g. library or file sharing, document repositories, newsletters, and calendars), can be harnessed to serve the organisation of knowledge production through community. This task is one he sees as requiring careful cultivation, to ensure individual participation (e.g. with the help of on-screen facilities such as navigation and site index icons, individual page profiles, scratch pads, question and answer icons) as well as build community (e.g. with the help of tools such as connection finders, subgroups, member directories, and

discussion/reflection sites). In this reading, virtual platforms are seen to allow relational proximities to be 'stretched' across time and space.

One of the tasks of these platforms is to bridge the gap between the tools of technology management and the tools of community management. Smeds and Alvesalo (2003) discuss an interesting experiment by a global American telecoms company to strengthen links between dispersed R&D units and dispersed operations units in order to improve the adoption of new products. The experiment involved a live process-design simulation exercise over a full working day involving 40 people in one site and 25 in another, aided by a tele-visual link. During the simulation day, participants talked, wrote down notes, put stickers on walls, and so on, as one R&D project was presented and changed through active participation at both ends. The result can be counted as a modest success in establishing a temporary virtual community, in which careful cultivation of the techno-social infrastructure for collaboration played an important role.

It is clear that the management of distributed communities involves much more than choosing the right technological tools. For example, in an insightful comparative study of 18 virtual communities in 14 organisations – public, private sector, para-statal and professional - Dubé, Bourhis and Jacob (2005) found that success can be related to three structuring characteristics: the level of organisational and managerial support available to the virtual community; the relevance of the virtual community's objectives to its members' daily work; and the formal institutional status of the virtual community within the organisation.[13] It makes a difference when employees in an organisation know that communities of practice are a knowledge management tool of choice for their senior managers. For example, the explicit shift by Caterpillar from a silo-based knowledge management structure in 1999 (supported only at the margins by a dozen or so communities of practice) towards 'Knowledge Network', an intranet-based system serving over 3000 local and virtual communities of practice by 2004, is judged to have provided a significant managerial incentive (Powers, 2004).

Such efforts, others have argued, are far from guaranteed if member motivation is not addressed. Another study of three virtual communities in Caterpillar (one large, established and well-known, and the other two struggling to establish themselves) found that an important incentive for participation was the moral obligation in a community to knowledge exchange, guided by the view that knowledge is a public good (Ardichvili, Page and Wentling, 2003)[14]. It seems, therefore, that in addition to the technology management issues raised by Wenger and his colleagues, organisations relying on virtual communities need to attend to other structuring tools. These include addressing problems of leadership and relevance within each community; realigning management culture in order to recognise the presence and significance of virtual communities; and, as Ardichvili, Page and Wentling (2003) conclude from their study, promoting multiple channels of communication among

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[13] All of the virtual communities they studied were operational, small, young, temporary, and created top-down following a prescribed leadership structure, with degree of success measured in terms of health of activity and survival of the community. The researchers found that while all the failed experiments faced an obstructive environment, the successful ones faced a supportive or neutral environment, which included such characteristics as active and imaginative leadership from the community coordinator, senior and middle management recognition as well as understanding of the governance implications of relatively autonomous horizontal groupings, provision for the specific technological, training and social needs of the virtual community, and the management philosophy towards knowledge sharing. Similarly, as regards the question of relevance, they found that given that intentionally formed virtual communities lack common content, purpose and identity at inception, success depended on how far selected topics for discussion resonated with the daily concerns of members, and on members feeling that their contributions were worthwhile, both within the community and in terms of influencing change to rules and procedures in the organisation at large.

[14] We do not wish to overplay this point. The study also found participation to be affected by fears of losing face or ridicule in posting material, the efficacy of the network as a problem-solving tool, and the tightness of local face-to-face links, which tended to discourage virtual participation.

communities, ensuring that the culture of the 'net' does not breed fear, and seeking to build trust and moral obligation in the area of knowledge sharing.

Sustaining such cross-community dialogue in ways that might facilitate the formation of new virtual communities within a dispersed organisation is a major management challenge, one that is closely linked to the dilemmas of sharing unique knowledge practices between communities. Communities lacking prior acquaintance or working contact with each other are not likely to be nudged into a new working culture by a day of active learning via simulations, role play, or joint enterprise in a virtual environment. The technologies and associated innovations in mediation can only temporarily affect the rich and nuanced sociality of work in each site, embodied in knowing glances, bodily gestures and jokes that mean everything in a given community of practice. Even when an array of boundary objects is put into place to facilitate cross-community collaboration (e.g. integrated timelines, capability roadmaps, diaries of scheduled meetings, status reporting rules), in the absence of strong familiarities between the communities, the potential for local breakaway or peripheral participation alone by individual communities in the joint virtual project will remain high[15].

That the risk of misunderstanding, reticence, and suspicion might be high is hardly surprising, given the nature of ties born out of situated practice within communities. Yet, what is interesting about the example cited by Smeds and Alvesalo is that despite the limitations of virtual communication between communities, joint problem solving *is possible*. Pan and Leidner (2003) cite the case of a large US specialty chemicals corporation with operations in 21 different countries, showing how it rapidly evolved from relying on a single, IT-based model of best practice transfer (that struggled due to linguistic and cultural obstacles),to using a multi-media virtual environment that encouraged individuals to participate in multiple communities of practice so that they could get used to varied modes of communication, and also developed regional conventions of communication in order to build on common linguistic and cultural traditions.

An important insight is offered by this example. There is a tendency to think of virtual communities or virtual communication in distributed organisations as an alternative form of knowledge production and management to other forms. In contrast, it may be more fruitful to think of the corporate knowledge domain as a community of communities with varying sociologies and geographies (Amin and Cohendet, 2004). This allows us to think of organisations as multiple communities of varying stretch and reach, each with its own knowledge practices and each with its own links with other knowledge domains, reliant on different mixes of virtual and non-virtual communication. Viewed as such, the challenge of virtualisation becomes one of linking and bridging a multiplicity of often conflicting knowledge practices, and one of combining with the non-virtual in different ways and degrees, rather than one of producing knowledge through virtual means alone. The core issue then, as we have tried to argue in this section, is how distance can be bridged through a series of relation-building tactics, involving both sophisticated means of technological communication and other modes of enculturation, such that, over time, the technological infrastructure becomes part of the social fabric of managing spatially dispersed relational ties.

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[15] Note, however, that even when communities come together physically there will be uncertainties until members become familiar with each other and develop over time a mutually supportive/acceptable sociality. It may be, therefore, that time and experience can help to overcome some of the difficulties, once a distanciated arrangement begins to build up its own sociality.

Online Communities

To read the technological infrastructure as an inseparable element of the string of material, virtual, cognitive, and non-cognitive inputs that is involved in knowledge production is simultaneously to recognise the granularity of situated practice in different associative settings. This is precisely why it is important not to treat social spaces with superficially similar technical coordinates as the same. Online groups are a case in point. At one end of the spectrum lie large, loosely structured chat-rooms, and at the other end lie small, purposeful, and managed online groups, with all manner of variety in the middle. This ranges from newsrooms that allow material to be read and posted but involve little interaction, online databases and repositories that permit some degree of manipulation, clubs and game sites that involve intense interaction and emotional attachment, specialist groups that communicate with varying degrees of frequency, expertise and specificity, and online experiments designed explicitly to broker knowledge exchange and learning. As Kling and Courtright (2003) note, not only are there huge differences in technical, social, and institutional specification, but online groups also vary in their norms about who can participate, the genres of communication, the activities (speak, post, read, role-play), the conventions of interaction, and protocols of organisation and control (p. 222).

This variety has an important bearing on the role of online groups as knowledge communities. In the majority of cases, conversations circulate rapidly and temporarily among many participants who barely know each other and who come and go at high frequency, propped up by fairly rudimentary design and data-processing facilities, and minimal attempts to control, channel, and structure the conversations. Learning outcomes, if any, tend to be the consequence of foraging rather than the product of collective and mutual engagement. Open and unstructured online groups, notwithstanding the textured nature of social interaction within them, are not in the business of generating new knowledge through virtual interaction. It is important to recognise this, especially in light of the burgeoning literature on social capital in online communities, which is prone to interpret evidence on shared expertise, trust, or mutual engagement as a sign of collective knowledge formation (Davenport, 2001; Trentin, 2002)[16].

There are, however, other studies of online groups that *are* interested in their learning and knowledge dynamics, which we turn to next. Two types of virtual communities of learning stand out from the available literature. These are, firstly, innovation/expert-based projects that on occasions can be exceptionally large and involve open access, and secondly, bounded interest groups consciously organised as knowledge communities facing particular problems. Open source software development, involving many participants interacting with each other on a purely virtual basis, is a good example of the first type of community. Typically, these are limited-life projects in which the source code for the software is freely available to those technical experts who are motivated by the challenge to solve a particular

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[16] The dynamics of social capital formation too are varied in online networks. For example, Hung and Nichani (2002) note that online forums should be seen as quasi communities in which social capital is more difficult to form than in situations in which participants have access to a variety of means of communication and social exchange, including joint endeavour and face-to-face interaction. However, there is also a body of research that clams that online communities are capable of generating social capital. For example, Kavanaugh et al (2005) in their study of an experimental community computer network in Blacksburg, Virginia, argue that the internet helped to increase both strong ties within social groups (bonding social capital) as well as weak ties across social groups (bridging social capital). While in this study the online interaction was within a small university town and therefore complemented by other, non-virtual, forms of local interaction, the authors are clear that heavy internet use strengthened the formation of bridging capital, which, in turn, resulted in higher levels of community involvement, civic interest, and collective efficacy, along with higher sociality on and off-line. Other studies, in contrast, have explored the possibilities of building social capital through online contact alone, concluding that initiatives that bring like-minded people or topic-based groups together can significantly enhance social capital with the help of appropriate technologies that prompt dialogue, integrate shared repositories into communication pathways, match actors from personal data, and augment visualisation (Huysman and Wulf, 2005).

programming problem, and keen on peer recognition. Successful projects seem to be guided by shared notions of validity among participants, contributions from a core group of contributors, internet services (often organised for sequential dialogue and stored knowledge), and a maintainer who is often the originator of the project and who actively directs the flow of discussion and achievement.

According to Edwards (2001) the learning dynamics of successful open source software projects, such as Unix and Linux, can be compared to those of epistemic communities. How valid this comparison is, when many expert communities tend to be closely knit and involved in longer-term and cultivated relationships between participants, is a matter of conjecture. However it seems clear that, in certain circumstances, large virtual networks with modest levels of community belonging, social capital, and inter-personal contact, can develop problem-solving abilities based on collective knowledge accumulation. This can be attributed to a different but equally effective sociology of engagement, but, as in epistemic communities, one characterised by strong attachments to the object. According to Wasko and Faraj (2000), whose large survey of three Usenet technical communities, shows that people collaborate not only in the expectation of tangible returns (e.g. getting an answer to a technical problem), but also for intangible reasons that include meeting similar minds, learning from solutions offered, peer recognition, moral obligation towards helping others in a common technical community, and maintaining standards, together with spreading ideas. Some of these characteristics are present even in more instrumentally established online communities. For example, in their study of enthusiasts who joined an e-group offering a prize of £10,000 to the first to break the 10 codes presented at the end of a Simon Singh's book CipherChallenge, Hall and Graham (2004) show that while some were motivated by the possibility of winning the reward and were free-riding for individual gain, many others were prepared to share valuable knowledge, as well as to cooperate with other enthusiasts, for 'soft' rewards such as personal satisfaction and peer recognition.

It is this kind of 'soft' culture that perhaps also helps to explain why open source networks that allow information to be edited and changed by anyone do not collapse into a heap of gibberish or offending material. For example, on a Wiki website anyone can edit an entry and there is little to stop a malevolent user from deleting or changing valuable material. In reality, however, as Neus (2001) notes, what needs to be explained is why disasters rarely occur, going on to offer the explanation that 'although *any* user can change any page, the changes are stored in a log and *any other* user can review that log and instantly undo any change that he or she does not approve of' (p. 5). Such safety nets, according to Neus, act as a stimulus for collaboratively creating and improving information, as seems to have been the experience of the Wikipedia project, which has generated thousands of submissions that are subjected to a rigorous review process before being finally accepted for the encyclopaedia.

However, Hall and Graham's (2004) clear claim is that while all-inclusive online communities provide opportunities for individual learning, they do not support new knowledge generation based on genuine collaboration as a shared collective resource. For them, such knowledge is generated in smaller, less open groups, which brings us to the second type of virtual community we wish to discuss. Recent years have seen the rapid growth of online initiatives established purposely to share or advance knowledge among professionals, experts, or lay people, interested in resolving specific problems, such as groups of teachers or health professionals interested in developing and exchanging best practice in the classroom or in medical practice, or patients and carers wishing to learn about, and influence, health policy in specific areas of illness. The literature that we have reviewed shows that, when explaining the success of such virtual networks, size may be of less significance than

the degree of participant commitment towards the endeavour and to each other, the clarity of purpose and rules of engagement, and the qualities of leadership and intermediation.

For example, in one study of why a managed online experiment, involving 20 librarians from different backgrounds in a discussion of knowledge management issues, was 'slow and grudging' (Cox, Patrick and Abdullah, 2003) blames seven factors: (a) lack of time for the community to form; (b) insufficient critical mass; (c) excessive diversity within a group in which members did not know each other; (d) lack of a tangible or clear enough focus; (e) limited incentive to participate; (f) lack of time set aside by participant organisations for the members to participate in the experiment; and (g) failure of leadership and shared interests to emerge among the group. As Kling and Courtright (2003) note 'transforming a group into a community is a major accomplishment that requires special processes and practices' (p. 221). Through their study of an elaborate website in Indiana, established to support inquiry-based teaching practices among secondary school science and maths teachers, that, while the project developers expected a community of practice to emerge once the technology for textured communication online was perfected, in reality, success was the outcome of sub-groups emerging, sustained by a clear purpose and iterative exchanges between the teachers. The key factors they single out are: (a) meeting offline in order to build familiarity and trust; (b) organising into groups facing similar problems; (c) support from creative and knowledgeable e-forum managers; and (d) use of the question and answer style, together with encouragement of reflective or thinking-aloud prompts. These factors, notably the possibility of face-to-face contact, shared background, and task- or problem-specificity also recur in other studies of learning-based online communities, such as Cox and Morris's (2004) study of a discussion list for web developers, Johnson's (2001) survey of 16 different online ventures, and Tracey, Fowler and Penn's (1999) study of a 'home learn' online educational experiment drawing together a community of parents, children, and teachers.

In all these studies it is the anthropology of communication, contact, and purpose that emerges as a significant influence on learning capability in online networks. It is an interactive space that cannot be reduced to trust and social capital (even if they can lubricate certain circumstances). In virtual networks there are clear limits to the depth and quality of trust that can be built, but the few examples we have explored demonstrate that this need not hamper collective virtual learning, underpinned by a strong sociality. This is well illustrated by Josefsson's (2005) study of patients' online communities in Sweden which have become important media of information exchange and therapeutic knowledge, especially in poorly understood illnesses, by allowing distant patients, carers, and professionals to communicate with each other. These communities, which on some occasions have influenced medical policy and practice through their situated knowledge of symptoms, life circumstances, and curative support, are capable of establishing a rich texture of communication and affect. For Josefsson, when the networks are mediated by an experienced and sensitive manager and characterised by a 'netiquette' of civil and sensitive language, they can develop a culture of engagement replete with humour, empathy, kindness, sensitivity, tact, and support. This culture not only facilitates often painful and highly personal issues to be posted and discussed, but is also the lubricant of learning and new knowledge formation.

This is not in any way to ignore issues relating to the quality of the technological infrastructure of online communities. As Cox and Morris (2004) note, a critical weakness of the technology is that it 'offers one undifferentiated space, rather than allowing sub-groups to quickly form and work on a particular issue or project, then disperse. There is no "backstage", nothing is off the record, everything is public and

archived' (p. 8). Indeed, given the limited possibility for face-to-face familiarity, the ability of the virtual medium to become more than a technological infrastructure is a crucial factor. This seems to be aided when the screen is able to offer simplicity and clarity of negotiation, channel, memorise and re-activate dialogue and data, work in different time spans, and encourage and sustain reflexivity. What is interesting is that a new generation of software is available to alow large sets of information to serve virtual communities of practice. For example, hypermedia, interactive digital libraries, and other technologies are enabling electronic memories to support 'emergent, dynamic, exploratory interpretation' (Marshall, Shipman and McCall, 2005: 7) along with providing visual symbols that allow people to see and express an information structure as it becomes apparent to them.

In summary, virtual communities of practice seem to work best as developers of both incremental and new knowledge when the technology can be 'softened' as well as integrated into a 'net' sociality that is able to support high levels of purposefulness, social interaction, and affective commitment. Many online communities fall far short of being communities of practice, that is, sources of learning and knowledge formation based on practices of collective engagement. However, the examples of success reveal that online communities can replicate the rich texture of social interaction that we would normally expect from communities of everyday facial interaction marked by high levels of trust and reciprocity or strong professional and/or project ties. This ability is related to a combination of factors working to perfect a net-based anthropology of interaction lubricated by common purpose, problem-orientation, professional competence, intermediation and cultivation, and affect at a distance.

3. Cultivating Communities

The literature reviewed in the previous section gives an indication of the wide variety of existing studies on CoPs. It is clear that CoPs differ from one another in a number of important ways. An appreciation of this variety is important for managers and policy makers attempting to promote CoPs as a knowledge generation and dissemination mechanism. In the review above we have identified four groupings that appear to have distinctive characteristics, yet simultaneously display a degree of internal consistency: craft/task; professional; expert; and virtual. This is not to claim the absence of commonalities between these groupings. For instance, scientists in expert communities are often also members of the academic/educational or medical professions. Many professionals and experts are involved in virtual communities and some elements of the work of experts may be very similar to that undertaken in craft or task based communities. Despite these overlaps, we consider the typology outlined in Table 2 to be helpful when seeking to determine the nature of social interaction, innovation, and organisational dynamics relevant to particular CoPs. What is clear from the review is that CoPs in different fields and contexts offer diverse opportunities and challenges, hence they may be more successful in certain settings rather than in others.

In this final section, and by way of conclusion, we focus our reflections on two areas. The first of these relates to the implications of CoPs for knowledge management in organisations and firms. The second area of focus concerns the spatial and relational characteristics of CoPs and the subsequent implications for knowledge and learning at a regional level.

Organising and Innovating through Communities of Practice

The early caution over how far CoPs can be created or mobilised through active management has given way to an almost formulaic and hopeful set of governance credos. Lave and Wenger (1991) originally made it clear that CoPs cannot be formed from scratch. For example, a business can establish a team for a particular project, which might in time, emerge as a community of practice. But management cannot establish a community of practice. What it can do is facilitate the spontaneous emergence of communities of practice and support those that do develop. As Brown and Duguid (2001a) suggest, managers can seek to structure spontaneity; in particular, they have a role to play structuring fragmented practice across their organisation. On the one hand, managers have a role supporting the development of communities of practice, on the other they can encourage alignments of changing practices between communities, thereby assisting the transfer of knowledge across the organisation (Brown and Duguid, 2001a). Yet, as we have seen, much of the existing literature concerning CoPs assumes that they can be directly managed and used as a real or rhetorical tool to manage professional and expert workers over which organisations have little authority.

Although the focus on knowledge as a social practice in the CoPs approach is valuable, and welcome following the overwhelming attention given to the codification of knowledge and the application of information systems in knowledge management strategies in the 1990s, much business and management literature concerning the promotion of CoPs provides formulaic and overly-simplistic analyses. As we have seen in the previous section, social practices are varied and have multiple dimensions, with quite different meanings for knowledge generation in different arenas of collective practice. Social practices can be embodied in institutions and cultural conventions, or they might be emergent and only available to small groups of individuals. In turn, the knowledge practices of craft workers are quite distinct from those of epistemic communities, professional collaborations, and virtual networks, as we have seen, confirming Orlikowski's (2002, p. 249) claim that 'knowing is not a static embedded capability or stable disposition of actors, but rather an ongoing social accomplishment, constituted and reconstituted as actors engage the world in practice'. Knowledge in practice thus defined – dynamic, emergent, variegated – escapes the blunt instruments of management intervention.

Even so, more recent contributions suggest that communities of practice can be cultivated and leveraged for strategic advantage (Wenger McDermott and Synder, 2002; Saint-Onge and Wallace, 2003). In line with this view, an increasing numbers of consultancy firms are offering to improve their clients' abilities to manage knowledge creation and dissemination by identifying or establishing communities of practice.[17] More generally, managers are seeking to develop and support communities of practice as part of their knowledge management strategies, and communities of practice can, in some senses, be viewed as a new organisational form (Wenger and Snyder, 2000, Wenger, McDermott and Synder, 2002) that can create value and improve performance (Lesser and Storck, 2001).

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[17] The French firm Knowings is an example of a consultancy promoting the community of practice as a knowledge management tool, details available at www.knowings.com (last accessed 30/11/05)

Table 3 Seven Principles for Cultivating CoPs

Principle	Features
1. Design for evolution	Communities usually develop from existing personal networks. The dynamic nature of communities is central to their evolution. Design elements should be catalysts for a community's natural evolution. Social and organisational structures, such as a community coordinator or problem-solving meetings, can facilitate the evolution of a community. Design for aliveness.
2. Open a dialogue between inside and outside perspectives	Good community design requires an understanding of the community's potential to develop and steward knowledge gained from both inside and outside the community. An outside perspective, whether achieved through community education or the dialogue with an 'outsider', allow insiders to see new possibilities.
3. Invite different levels of participation	Expecting all community members to have the same level of participation is unrealistic. Three levels of participation and their approximate corresponding proportion of total membership are identified: core group (10-15% of members) at the heart of the community; active group (15-20% of members); peripheral group (up to 65% of members) who rarely participate. Members can move between these various levels. The key to good community participation and a healthy degree of movement between levels is to design community activities that allow participants at all levels to feel like full members.
4. Develop both public and private community spaces	Dynamic communities are rich with connections that occur in both public and private places of the community. The key to designing community space is to orchestrate activities in both public and private spaces that use the strength of individual relationships to enrich event and use events to strengthen individual relationships.
5. Focus on value	Many of the most valuable activities are the small everyday interactions – informal discussions, or one-to-one exchanges. Designing for value requires encouraging community members to be explicit about the value of the community.
6. Combine familiarity and excitement	This combination allows members to develop the relationships they need to be well connected as well as generate the excitement they need to be fully engaged, and to challenge their current practices with a view to developing new products and processes.
7. Create a rhythm for the community:	There are many rhythms in a community – the syncopation of familiar and exciting events, the frequency of private interactions, the ebb and flow of people from the sidelines into active participation, and the pace of the community's overall evolution. Finding the right rhythm is key to a community's development.

Source: Summarised from Wenger et al. (2002, p. 51-63)

In a sense, while scholars have accepted that important elements of knowledge can only be shared through social practice, the solution of some management scholars and practitioners has been to devise methods to codify social practices with a view to facilitating the transfer of tacit knowledge. For instance Wenger et al (2002, p. 51-63) outline seven principles for cultivating CoPs, which are briefly summarised in Table 3. While these principles undoubtedly capture important dynamics of practice-based learning that need to be grasped in new ways by management, they skate over important corporate parameters that shape the scope and nature of possibilities. We elaborate on these restrictions in the following paragraphs and, while our intention is not to dismiss the possibility of cultivating CoPs, we remain sceptical of the reach of formulaic or imprecise principles of cultivation and management.

Firstly, the design for evolution principle assumes that communities will continually develop. Yet a changing business environment may lead to extinction as a community becomes redundant. Alternatively, a CoP may have a short lifespan, giving little scope for evolution if, for example, it is established for a specific purpose which, once achieved, leads to its dissipation, like the project based groupings which Lindkvist (2005) refers to as collectivities of practice. Moreover, power relations within CoPs may hinder evolution if it challenges the status quo, as is evident in the studies of professional CoPs in healthcare (Swan et al., 2002; Bullough et al. 2004). Additionally, those designing the community may have specific interests that influence the evolutionary path, or lead to inertia.

Secondly, opening a dialogue between inside and outside perspectives will be influenced by the interests of insiders and outsiders, and this will vary according to the activity and the nature of the knowledge at the centre of the community. For instance, a CoP in a professional sector may be open to new knowledge from other CoPs in the profession, but closed to knowledge from other professions or non professional sources. Openness to outside perspectives will be mediated by a range of differences, including standards, cultures, ethics, and so on. For knowledge to be successfully mobilised, transferred, or shared, alignment between insiders and outsiders is crucial. Boundary practices in the form of processes or objects are important in this respect, as we have seen. In their analysis of the work of a museum of vertebrate zoology, Star and Griesemer (1989), for instance, identified four boundary objects: repositories, ideal types, coincident boundaries, and standardised forms. Because these boundary objects held meaning, albeit a somewhat different, though related meaning, for the various groups contributing to the work of the museum, they facilitated the communication of knowledge and information between these diverse groups.

Though the attention of much has been directed towards understanding the structure of CoPs, issues of alignment, including boundary objects or processes, require further attention, for it is through these interactions that knowledge is shared between different groups. Researchers have considered a wide range of boundary processes, from the tools and artefacts that workers use in their every day practices, such as the particle accelerators used by high energy physicists (Knorr-Cetina, 1999) or the forms processed by insurance claims processors (Wenger, 1998), to the subject of their labour, whether this be a partially constructed flute, in the case of flute makers (Cook and Yanow, 1993), or a patient, in the case of medical practitioners (Freed, 1999). According to Wenger (2000), other boundary processes include key individuals purposely acting as brokers between the inside and outside of a community, boundary interactions between individuals from separate communities, and cross-disciplinary projects. Encounters with different perspectives achieved through boundary processes can lead to the reflection required to change one's own

perspective, or to develop fresh insights. Consequently, the intersections between CoPs may be valuable sources of new knowledge-creating capacity. This is particularly the case within professional sectors where the inertia resulting from the benefits of professional status can undermine the drive for creativity. Interaction with related communities can provide the necessary stimulus to challenge and change existing practices. However, opening a dialogue between inside and outside perspectives, as Wenger et al. (2002) suggest, may lead to interaction between largely unrelated communities with potentially more creative and/or disruptive consequences. Moreover, as the example of interaction between mainstream scientists and indigenous peoples (Rist, Zimermann, and Wiesmann, 2004), noted earlier, suggests, sometimes there is little scope for alignment. The boundary processes in such circumstances have yet to be explored.

Thirdly, it is important to recognise that the boundaries of CoPs do not align with those of the organisation. For instance, a CoP may arise from an occupational or professional association, such as the association of women in Internet design and development occupations investigated by Benner (2003) to evaluate the role of CoPs in supporting individual and collective learning processes in Silicon Valley. Similarly many virtual communities such as the Open Source Software community discussed by Edwards (2001) are not limited by organisational boundaries. While such extra-organisational CoPs can be beneficial to the organisation, the challenge for managers is to ensure that such benefits outweigh the possible detrimental impact of an outward flow of firm-specific knowledge. As we have seen in the various communities reviewed, members may identify more closely with their community than with the organisation within which they are employed. When communities are extra-organisational, managers need to be aware that community members' loyalties may lie beyond the boundaries of the organisation. The development of a strong corporate culture may go some way towards counterbalancing the divided interests of employees. Alternatively, the alignment of organisational and community interests, where possible, will alleviate the risks associated with the divided loyalty of employees. Resorting to contractual mechanisms to prevent employees disseminating firm-specific knowledge beyond the boundaries of the organisation may be counteractive, since it reduces their employees' ability to participate in extra-organisational knowledge communities.

Fourthly, the development of both public and private community space, promoted by Wenger et al. (2002), requires an appreciation of where the line between the two types of space lies. It is assumed that communities within organisations have access to both public and private space. In the context of sticking to defined collective and corporate goals, it is questionable whether organisations are able to concede corporate space for private ends, especially when these ends might begin to encroach upon the corporate goals, including, for example, share-holder interests. It is also the case that, in smaller organisations lacking the capacity to provide workers with space beyond that required for immediate productive use, the room for private community space is limited. In the highly creative web design project studied by Thompson (2005), management provided opportunities for informality, and sought to blur the line between public and private space in the organisation, through the formal encouragement of the informal interactions that support sociality and creativity. Yet, as Thompson (2005) reveals, even in a large international IT firm the scope for maintaining high levels of informality is subject to challenge in a demanding business environment. Also, it has to be noted, such private space may result in the enhancement of the benefits for individual community members at the expense of the organisation if, for example, competitiveness is undermined by the dissemination of knowledge beyond the boundaries of the organisation. The challenge for business organisations is to appropriate the benefits from the relationships and knowledge

exchanges that occur both in public and private spaces within the boundaries of the firm, as well as in spaces that are external to the organisation and beyond its control.

A fifth limitation arises from the impact of the broader organisational, sectoral, economic, and indeed national context, on attempts to engineer practice through the development of CoPs (Roberts, 2006). For instance in a sector or organisation facing economic decline or restructuring resulting in job losses, it would be difficult to develop and sustain a trusting relationship between community members made up of managers and workers. Arena, Lazaric, and Lorenz (2006) find that one of the main challenges to establishing an epistemic community in the French steel industry relates to the development of trust. Social practice both influences, and is influenced by, a variety of factors such as trust, beliefs, manners, and cultural norms. Consequently, these factors will also impact on knowledge generation and dissemination when they occur through social interaction.

Sixthly, the value of the CoP approach might be in danger of losing its specificity, Indeed, Brown and Duguid argue that all but the smallest of organisations should be regarded as communities of communities of practice, proposing the term networks of practice for group interactions that are significantly looser and more impersonal than those in a CoP (Brown and Duguid, 2001b, p. 205)[18]. The general point that can be made is that the use of the term CoP to describe different types of situated practices diminishes awareness of some of the knowledge limits of CoPs, as originally defined. It is important to recognise that CoPs can, in some instances, undermine innovation by becoming resistant to changes in their knowledge base. Knowledge that is aligned with the specific predispositions of a community and supports the identity and current practices of its members is more likely to prevail than knowledge that challenges current identity and practices. Professional communities appear to be particularly resistant to innovation due to the institutionalisation of knowledge and the development of professional interests. Nelson's and Winter's (1982) seminal claim that ways of doing things can become institutionalised within routines is particularly appropriate for CoPs, characterised as they are by relatively stable patterns of interaction. Grabher's (2004) comparison of project teams in the computer software and advertising sectors provides an interesting contrast between two different types of working practice. He found that teams in the computer software businesses that gave priority to the accumulation and sedimentation of knowledge, tended to remain stable over time in terms of membership, while the project groups in advertising, which placed a high priority on creativity, changed membership regularly in order to retain high levels of creativity through the recombination of different knowledge. These findings would suggest that certain activities, such as those requiring the ongoing preservation or development of a body of knowledge, might be more suited to communities of practice than those which require continuous radical change to simulate the creative production of new knowledge. Managers seeking to adopt CoPs as a means of stimulating knowledge generation and learning should be aware that they may not be the ideal vehicle for the promotion of radical innovation.

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[18] Alternatives terms, restricting CoPs to a specific mode of learning, might help to differentiate between different types and patterns of interaction. Gherardi (2006, p. 110), for example, has proposed to use the term community of practitioners rather than CoPs, in order to place the emphasis on 'practice' rather than 'community', in turn also redefining community as 'an effect, a performance, realised through the discursive practices of its members'. Similarly, Lindkvist (2005) uses the term collectivities of practice, to refer to temporary groups or project teams concerned with knowledge creation and exchange. According to Lindkvist (p. 1200), such groups 'with members that embrace a collective goal and have a good representation of what others know, may thus, based on quite a minimalist base of shared knowledge, develop a pattern of interaction and the collective competence needed'. While communities of practice depend on shared enterprise, mutual engagement and shared repertoire, collectivities of practice rely on individual knowledge, agency and goal-directed interaction. Another alternative, illustrated by our attempt to construct a tentative typology of practice based approaches, is to distinguish between different types of community (craft, professional, epistemic, virtual, an so on).

Finally, as an inherently social account, the CoPs perspective is distinct from more individualistic accounts of human behaviour, including economics (Duguid, 2004). While the CoPs perspective – and the social practice approach in general - has offered important insight into the value and dynamics of knowing in action, its growing appeal has tended to overshadow longer-standing accounts stressing the codified, possessed, or instituted, dimensions of economic knowledge.[19] For example, the dynamic of knowledge locked up in competences, patents, institutional repertoires, memories and archives available only to some economic actors, intellectual property rights, national and regional systems of innovation, and so on, remains a crucial force. It conditions the possibilities on offer to knowledge-generating networks, it influences the way in which the fruits of innovation and learning are appropriated and protected by businesses and organisations, and it conditions the institutional environment in which firms and their networks operate in different regional and market settings. The incentive of ownership of new ideas and techniques is a powerful driving force for creativity and innovation and, given the continued dominance of knowledge as property, practice-based approaches have everything to gain from dialogue and debate with economic and legal approaches, which are better equipped to deal with issues of ownership and appropriation of rights over knowledge, whether achieved through traditional intellectual property rights, employment contracts, or other legal instruments. In managing knowledge, any failure to take account of these factors relating to knowledge as a possession - bounded by property rights and organisational appropriation in order to gain competitive advantage - is to forget that knowledge is made to count economically through such ownership and control.

Thinking Space: Regional Policy Implications

The turn in the literature on the knowledge economy towards the ethnography of living communities of practice might be read with some hope by those local policy makers keen to redevelop the local economy through a step change in the knowledge base. This is especially so in cities and regions facing long-term economic stagnation, a history of failed attempts to radically alter the economic base, over-reliance on a narrow set of sectors and firms for economic advantage, and a relatively weak supply/institutional environment to support new learning and innovation. Weary of the disappointments of science and technology-driven models of local economic regeneration (because of poor incubation results, inadequate uptake, a poor supply base, weak links between the research and business communities, or simply the sheer might of more established centres of growth) policy makers in such places may be drawn to a different model of knowledge-based economic renewal. A CoPs perspective might appeal because of its emphasis on situated practices, soft sources of innovation and knowledge generation, and the strength of relational ties. It might imply that, with the right policy instruments to capture and stimulate the latter (along with various other factors identified for different types of community in this paper), existing firms, institutions and networks might be able to explore/exploit new knowledges developed through routine or purposefully-organised joint work. In some ways, the CoPs perspective stimulates policy thinking to return to an earlier tradition of research that emphasisedthe significance of work practices, embedded traditions, grounded knowledge, and process, but now through a different set of coordinates, and as sources of new knowledge (rather than efficiency alone).

What potential there is for local economic renewal through communities of practice is centrally related to whether CoPs can be seen as localised entities. We have seen that communities come with varied geographies of organisation and social

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[19] See for example Hayek, (1945, 1937); Arrow, (1969) and Machlup, (1962) for discussions of the economics of knowledge. More recent contributors to this debate include: Cowan et al (2000) and Ancori et al. (2000).

interaction of practice, which, we would assert, will have a central impact on the potential they offer for local renewal. If some CoPs are trans-local, what might be expected from them in terms of local returns? In turn, even if CoPs can only be regarded as a site in a wider geography of knowledge formation, are there certain local externalities that might be nurtured in order to raise the quality of knowledge practices to be found in a given location? For example, are there lessons to be learnt from the ways in which urban sociality serves the interests of high creativity communities? These are the questions of spatial organisation that we focus on this last section, in order to frame future policy discussion on urban and regional renewal through communities of practice.

Lave and Wenger (1991) studied CoPs as sites of situated learning in real-time between co-located parties. However, as we have seen, much recent research has examined CoPs in virtual or distributed organisations, questioning the primacy of spatial proximity, proposing instead the need to appreciate the spaces of relational proximity in CoPs. Work on relational proximity continues to use the community metaphor to describe learning and innovation in spatially distributed networks (Amin and Cohendet, 2004; Knorr-Cetina, 1999), but tends to suggest that both types of interaction are not communitarian in the same ways.

Amongst economic geographers there has been a vigorous debate in recent years on the spatial parameters of tacit/community-based knowledge generation, with some commentators emphasising the continued significance of spatial proximity and embedded local cultures and others emphasising relational ties in trans-local networks (see Amin and Cohendet, 2004, for a summary of the debate). Initially, this debate was polarised around a 'local versus global' dualism in conceptualising the geography of (tacit) knowledge generation, with one side stressing the powers of local know-how, inter-personal ties, and local institutional or cultural amenities, and the other side considering the active work done by virtual connections and proximities struck at a distance through supply chain, corporate and travel and communications links. More recently, both sides seem to have accepted that local and trans-local relations are co-involved in knowledge generation, albeit in varying combinations. Both sides are beginning to see ways in which the local and the global contribute to knowledge generation (Gertler and Levitte, 2005; Lorenzen, 2005; Boschma, 2005; Bathelt, Malmberg and Maskell, 2004).[20]

One of the consequences of this development has been to re-think the nature of location and distance within knowledge spaces. For example, following studies in the sociology of science, a knowledge network might be imagined as a continuous but contoured space in which location, proximity, and distance are relationally, rather than geographically, determined (Callon, Law, and Urry, 2004), where all relational networks, regardless of their spatial reach, require active work by a range of intermediaries to hold them in place (Latour, 2004), and where flow, face, text, technology, and virtual space blend into one hybrid knowledge domain[21]. Thus, what determines the texture of, say, trust, or the qualities of situated practice, is not spatial

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[20] One of the off-shoots of this rapprochement has been an attempt to differentiate the knowledge work in local networks from that in global networks. For example, Malmberg and Maskell (2005) argue that localised knowledge creation draws on shared values and identities, underpinned by strong relations of trust, while global knowledge networks require a far greater degree of intentionality, organisation, and trust-building. The preceding discussion of virtual connections and multiple communities of varying spatial composition suggests however a potentially different way of conceptualising and differentiating knowledge space.

[21] Actor network theory makes it clear that the social and its interactive elements must be thought of as purposeful associations between humans, objects, technologies, and other entities including nature. In turn, it reveals how what is commonly understood as the technological infrastructure – codes, pipes, internet, wires, satellite, postal services, road networks, specimens, and maps - has to be recognised as an arena of social organisation bristling with intentionality and interactive intelligence, given especially the ever increasing calculative and analytical agency built into the systems. Thus, as Leigh Star (2002) notes, the technological infrastructure must be seen as 'that which is embedded; transparent; having reach or scope; is learned as part of membership; has links with conventions of practice; embodies standards' (p. 117), and ultimately, facilitates' heterogeneous cooperation' (p. 118).

proximity, but the nature of contact, intermediation, and communicative complexity involving groups of actors and entities. The point to be made is that geographies of knowledge are made by the constitutive relations and their architectures, not by pre-given spatial entities such as regions or corporate networks. The two might coincide, as in the case of craft/task-based networks that rely extensively on local social ties and face-to-face communication. But here too, if the knowledge gained from market transactions, supply chains, telephony and software, databases and print media, and virtual communications, were to be acknowledged, the tightness of fit would have to be questioned (Belussi, 2005).

To identify a spatial ontology of knowledge that is freed from having to think of space in purely territorial terms – bounded and scalar - is not to disregard the significance of urban, regional, and national space. A distributed knowledge network that consists of transnational connections, satellite communications, and routine flows between places always draws upon a rich set of site-specific and local resources in particular sites. We have learnt this amply from the literature on learning regions, offering local associational economies in the form of a rich institutional environment, cluster inter-dependencies, and developed circuits of social capital. Similarly, we have seen that in all the various types of CoPs reviewed here, situated practices, in some shape or form,necessitate local engagement, be it temporary, or through the sociology of intense interactions between face and screen. The issue, thus, is not whether relational space is territorially positioned, but whether the quality, intensity, and duration of spatially located practices promises potential for repetition, accumulation, and local spill-over.

Put simply, there is a connection between network space, territorial space and corporate space that needs to be explained in any given location. The nature of the intersection and play between these three spaces in a given city or region is crucial in determining the potential for local economic development. For example, in supply-rich regions such as Silicon Valley brimful of civic and professional associations as well as venture capitalists (Benner, 2003; Zook, 2004) – all known to be notoriously region-specific in terms of their contact networks and business commitment - linkage into scientific communities and commercial networks that are largely international in orientation (Saxenian and Hsu, 2001) has served to harness local and trans-local geographies of knowledge for local advantage. Accordingly, the region's knowledge nodes (within the global networks of different high-tech industries) have been able to retain pivotal advantage owing to the strength of links established between local communities of practice and the regional research, technological, associational, and human resource asset base, serving in turn to reinforce local ties[22]. In contrast, in regions devoid of local circulations of knowledge within professional and civic networks, inter-firm linkages and labour markets, specialist organisations, and in the public culture in general, the intersection between communities of practice linked relationally to other sites within their respective corporate, virtual, or professional spaces, is unlikely to generate significant local returns, as the draw of local relational ties is weak.

The significance of making this distinction between network space, corporate space and regional space, thus, is precisely to note the potential synergy, fusion, or clash between these modes of organisation, depending on the nature of situated practices, their wider transactional environment, and surrounding institutional and territorial conditions. These intersections define the geography of knowledge, with each spatial axis (office, building, region, internet connectivity, space of mobility and flow, virtual space, network architecture) contributing something specific to the

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[22] These same supply-side factors are responsible for encouraging the commercialisation of collaborative research between university scientists and firms (which remain peculiarly location-specific in very many science or technology intensive sectors – see Gittelman, 2003) in the form of start-up companies, in turn, heavily reliant on local linkages.

knowledge process, but not with sufficient autonomous force to claim a distinctive knowledge practice (e.g. face-to-face equating to trust-based interaction, urban buzz equating to high creativity, or virtual contact equating to relational thinness). We can also say this of specific knowledge sites, which are always hybrid in composition and always linked into multiple circuits of association.

Let us explore the example of financial trading in some detail to illustrate how perilous it is to read local knowledge as site specific, and in order to reveal how the various ecologies of knowledge practice that we have discussed intersect. This is an activity that simultaneously involves intense social interaction in spaces such as trading floors and stock exchanges, as well as equally intensive interaction in a virtual world supported by software intelligence, email exchange, sophisticated computer graphics and programming capacity, a face-to-screen visual culture, and endless telephone conversations. It is a high volume, highspeed, and fast moving trading activity that demands making sense of an extraordinarily high volume of information, laden with hidden messages, at the flick of an eyelid, and rapid-fire decisions that can make or lose vast profits on the basis of a gesture or an utterance. It is the instant that activates a complex knowledge ecology formed through education, training and experience, tacit know-how and instinct (Winroth, 2003), keeping alert and abreast, and familiar with the styles and tools of the trade (Zaloom, 2004).

The tangled geographies reveal an equally tangled ethnography of engagement in different spaces, making it increasingly difficult to differentiate between the spaces. For example, in their pioneering work on the ethnography of electronic trading in the foreign-exchange spot market Knorr Cetina and Bruegger (2002) show how traders sitting at their computer screens around the world should not be read as passive agents to whom a pre-formed market is *presented*. Instead, they argue that the 'face-to-screen world', has become an active site of market formation, one where the market is '*appresented*', that is, apprehended and moulded. They interpret the screen as a site of situated practice, interactively connecting traders with distant others, information sets, formulae that help interpretation, and software tools that facilitate visualisation and judgement. The computer terminal dances into play as a site of calculative practice, negotiation, evaluation, and action, linking trader know-how, evaluative and sensory skills, and sorted information. Thus, for example, the screen's visual display properties and the calculative capacity and speed of hidden software allow vast quantities of information to be quickly analysed and evaluated, while equally quick-fire teletype messages with brokers and traders elsewhere, imbued with communicative protocols, trading ethics, and interactive symbolism (including trust – MacKenzie, 2004), allow judgement and decision. Face-to-screen is a part of the market, with its material culture central to knowledge formation, in a space that is simultaneously local, dispersed, virtual and mobile[23].

The purpose of this example is not to reveal the social life of virtual space. Instead, it is to reveal the complex web of relational ties and the multiple agencies at work in even the most innocuous of sites. Every situated space (screen, office, trading floor, virtual community) comes with multiple connections, even when intensely localised interactions seem to be prevalent. Sticking to the example of finance, this is revealed by Beunza and Stark's (2004) rich ethnography of arbitrage

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[23] Similarly, in his study of different financial trading sites, including the open-outcry pit and electronically mediated trading, MacKenzie (2004) argues, firstly, that the relations in each setting are social in nature, involving as they do mutual susceptibility, imitation, and socio-technical agency, and, secondly, that all the interactions have 'local' dimensions in that they involve 'limited numbers of people who are in some sense known to each other, or at least the effects of whose actions are known' (p. 83). This relational interpretation of the 'local' opens up space for a varied set of geographies that can count as proximate, allowing MacKenzie to write in similar ways about the social ethnography of the Chicago trading pit and that of the electronic trading circuits, both marked by a sociality of inter-personal contact, trust, and moral judgement.

in a Wall Street trading room. The authors argue that the traders, though surrounded by an array of technologies and data that do not originate from the trading room, rely on a sense of the market that comes from 'a situated awareness … achieved by drawing on the multiple sensors (both human and instrumental) present in the room' (p. 381). So much so, that the physical lay-out of the room acquires central agency. For Beunza and Stark, the large and open plan room, with its parallel clusters of arbitrage specialists on the vertical axis, its sales desks on the horizontal axis, its floor manager at the intersection of the two axes, its whiteboard placed so that all can see the scribbled equations and options, is part of the fabric of managing innovation through the interactions it enables within and between specialist teams (steering talk, movement, visibility, display, consultation, bodily gesture, and exchange of objects). Significantly, though, Beunza and Stark are quick to dispel the idea that the situated knowledge of the trading room is bounded by its four walls, reminding us that 'calculation is distributed across socio-technical networks of tangible tools that include computer programs, screens, dials, robots, telephones, mirrors, cable connections, etc' (p. 389). Folded into the calculative possibilities offered by the trading floor are large Bloomberg screens, customised by individual traders for rapid response and programmed to automatically buy and sell according to the trader's tacit beliefs, and interpret an array of data to help instantaneous monitoring of prices and opportunities in different markets.

All these examples challenge the view that face-to-face or localised interactions are fundamentally different from those struck at a distance. This is a view that has allowed some who are keen to celebrate the local potential of CoPs to argue that local ethnographies of knowledge production are superior, or stickier, on the grounds of claiming that trans-local networks are socially thin and technology driven, while the latter are bristling with human possibility, familiarity and understanding. The clear implication of the counter-evidence is that efforts to regenerate local economies through investments in trust, social capital, and other modes of local social interaction, should not assume that any success in doing so will result in a unique form of soft knowledge that, in addition, sticks to the locality. We have tried to show that other relational proximities involving various geographies of organisation are also capable of generating soft knowledge which, besides, display other forms of spatial stickiness.

It follows from this observation that local attempts to mobilise communitarian knowledge need to attend to ways in which the intersections between network space, corporate space, and territorial space can be manipulated to work to local advantage. This is a matter of judging the geography and sociology of knowledge networks without prejudice, by viewing creative, craft, epistemic, professional, and virtual circuits as intrinsically without borders and equally textured. Then, the challenge becomes one of detailed evaluation of how different circuits of relational engagement can be made to work for local advantage. In part, the answer may lie in supply-side upgrading of a kind capable of sustaining a sociality of weak ties that encourages creative spill-over out of local firms and institutions, gradually forming a local institutional and public culture capable of energising new possibilities, regardless of whether individual communities of practice are locally or globally oriented. If the knowledge supply-base is rich, it will encourage local stickiness.

Conclusion

Necessity requires that this conclusion be brief. There are clearly many overlaps in the dynamics of knowledge creation rooted in different types of situated practice. On the other hand, in this paper we have tried to show that the differences also stack up. In the four settings of collaborative work we have considered, the contrasts in corporate, technical, and spatial organisation, together with those relating to the nature and intensity of social interaction, are significant in terms of the types of knowledge and innovation generated. One implication of this finding is that the rapid evolution of the term community of practice as a proxy for situated learning mightn't be helpful. The specific social and organisational characteristics of the task or craft based communities studied by the originators of the term seem to be barely replicated in settings of high creativity, epistemic, professional, or virtual learning and knowledge formation. It may, therefore, be more appropriate to develop a more heterogenous lexicon for different types of situated practice.

Such an endeavour makes conceptual sense, for in refining the understanding of this form of knowledge generation – embedded, embodied, encultured, activated, and always provisional – as a field of varied inputs, we may begin to appreciate that knowing-in-doing comes in many shapes and sizes (which, however, we can start to name). For too long has practice been seen as a single field of action, or one so situated that no categorisation is possible. This endeavour also makes practical sense, in helping policymakers and practitioners within organisations and regions to visualise different types of knowledge 'community', evaluate their potential for regeneration and renewal, and target the necessary specifics for inculcation.

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