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GOVERNANCE AND KNOWLEDGE EXCHANGE WITHIN AND BETWEEN EPISTEMIC COMMUNITIES

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ABSTRACT

All knowledge is context dependent. The relevant context is the social community where it resides, i.e. the '*epistemic community*' formed as groups of people define and legitimize the knowledge they possess. In the mutual engagement in a common enterprise, epistemic communities develop, maintain and nurture the *codes*, *tools* and *theories* that provide the basis of their practice. Commonalities of code, tools and theory facilitate both voluntary transfer and involuntary imitation of knowledge *within* communities, also ones spanning organizational boundaries. Conversely, knowledge transfer *between* different epistemic communities, whether desired or unintended, is often cumbersome and fraught with difficulties. In order to achieve effective integration and cooperation between its various professional communities and subcultures, firms must therefore undertake investments in boundary-spanning mechanisms. Since these investments are specific to the context in which they take place and to the transactions that they enable, they cannot easily be organized through arm's length contracts. Firms exist because they have a relative advantage over markets in the *integration* of diverse knowledge. However, the associated capabilities need not translate into a relative advantage also in the *transfer* of knowledge, i.e. knowledge exchanged between members of the same epistemic community. Within communities, knowledge disseminates with relative ease both intentionally and through emulation. Knowledge thus acquired can generally be applied also outside the context of the exchange and the effort or investment expended in its acquisition is not transaction specific. The governance mode applied in such exchanges is therefore determined by strategic and contextual factors, including those of traditional transaction cost logic.

INTRODUCTION

The activities of most firms require the mobilization and coordination of specialized and diverse expertise. However, the integration of specialized competences does not come about easily and will typically not be achieved unless requisite 'integrating devices' are in place (Lawrence and Lorsch, 1967). Recent research on the coordination and integration of the expert knowledge of diverse occupational groups has thrown new light on this and related issues.

Dougherty's (1992) studies of new product development teams illustrate the problems that occur when key participants from different 'thought worlds' fail to mutually take into account their varying interpretations of technological and market possibilities:

> A thought world is a community of persons engaged in a certain domain of activity who have a shared understanding about that activity…. Thought worlds with different funds of knowledge cannot easily share ideas, and may view one another's central issues as esoteric, if not meaningless. (Dougherty, 1992, p. 182)

This does not imply that members of different communities must reach agreement on all relevant interpretations of particular facts, proposed decisions or lines of action. Through communication, diverse groups can reach 'equifinal meaning' and be able to undertake common action in spite of different motivations and in spite of different interpretations of potential outcomes (Donellon, Gray and Bougon, 1986). Recently, detailed ethnographic studies by Carlile (2002) and Bechky (2003a, 2003b) have elucidated the mechanisms and processes whereby people from different occupational backgrounds manage to effectively communicate across the boundaries of their respective 'thought worlds' – without sacrificing the integrity of either. These studies provide empirical evidence on the processes of 'perspective making and perspective taking' (Boland and Tenkasi, 1995) that are necessary for the integration of diverse practices and cognitive traditions in the day-to-day operation of firms and other organizations (Grant, 1996a, 1996b).

This paper outlines some important implications of the perspective that these recent studies invite. First, they are clearly incommensurable with a unitary concept of the firm and the knowledge at its disposal, suggesting instead, as Grant (1996a, 1996b) has powerfully argued, a view of the firm as "…an institution for integrating knowledge." They thereby put into question the meaning of common metaphors, such as those of 'organizational knowledge' and 'organizational learning', emphasizing instead the contextual nature of knowledge, i.e. its embeddedness in the practice of specialized communities. Second, they call for a redefinition of concepts such as 'knowledge', 'knowledge transfer' and 'knowledge integration', all of which are central to whole range of theories and conceptualizations of firms and their activities.

The following discussion is based on the premise that knowledge cannot be meaningfully defined without reference to the group of people ('epistemic community') where it has been created and resides. As stated by Brown and Duguid (1991, p. 53), "… it is the organization's communities at all levels, who are in contact with the environment and involved in the interpretative sense making, congruence finding and adapting. It is from any site of such interactions that new insights can be co-produced." The first section of the paper proposes a model of three interacting knowledge elements – codes, theory and tools – that together can be used to describe the content and evolution of a community's knowledge.

The paper thereafter outlines some implications of the proposed model both for the theory of the firm and for the significance of knowledge in the resource-based view of strategy (RBV). It proceeds on the observation that the problems associated with the *integration* of specialized knowledge are different from the ones encountered when *transferring* knowledge within epistemic communities. The distinction reflects significant differences in the transaction costs associated with the exchange and exploitation of knowledge and has, therefore, fundamental implications for the selection of governance modes for such transactions. It has also implications for the imitability and substitutability of different kinds of knowledge assets, central concerns in the resource based view of strategy.

EPISTEMIC COMMUNITIES

The argument outlined in the following pages is premised on the conviction that all knowledge is socially constructed and context dependent. The knowledge context is defined by the social community where it resides.[1] Knowledge that is recognized as relevant and useful in one context may be totally meaningless in another.

> Within communities, producing, warranting, and propagating knowledge are almost indivisible. Between communities, as these get teased apart, division becomes prominent and problematic. Hence, the knowledge produced doesn't readily turn into something with exchange value or use value elsewhere. (Brown and Duguid 1998, p. 99)

Accepting – without going into the underlying epistemological assumptions – Plato's classical definition of 'knowledge' as 'justified true belief'[2], I shall assume that knowledge obtains economic significance through *application* in the performance of an economically meaningful activity, i.e. the exercise of a skill that it informs. When engaging in a common enterprise, groups of people develop, maintain and nurture the knowledge informing the skills of their practice. The framework outlined below therefore focuses on *communities of practitioners*, as the locus of both creation and exploitation of knowledge (Lave and Wenger 1991; Brown and Duguid 1991, 1998, 2001a, 2001b).

Through its practice, a community develops a shared understanding of what it does, the means and methods it employs, the standards by which its activity is judged, and how it relates to other communities and their practices – in all a 'world view' (Lave and Wenger, 1991). This understanding comprises the community's collective epistemic base (Mokyr, 2002). The processes of developing the knowledge base and the formation of the community itself are significantly interdependent: the practice develops the understanding, which can reciprocally change the community's practice and their members' view of themselves (Brown and Duguid 1998, p. 96).

[1] The minimum community size is two; there are forms of knowledge that only lovers share and can appreciate. Other kinds of knowledge seem so universal that they are probably shared by all human beings. Most types of knowledge relevant in managerial practice and for economic theory – the types that this paper attempts to address – lie in between these two extremes.

[2] Plato's definition is not unproblematic (c.f. Gettier 1963) but will have to do for the present purpose.

Membership in a community is obtained through the acquisition of its skills through formal training, apprenticeship or in other types of situated learning processes, such as those described by Lave and Wenger (1991) as 'legitimate peripheral learning'. Sometimes, communities recognize acceptance of new members through formal *rites-de-passage*: graduation ceremonies, the awards of master craftsmen's ensigns, or the granting of legal privileges to practice a trade; sometimes, recognition is more gradual, based, for example, on the number and quality of someone's publications in peer-reviewed journals or other tokens of ability to meet the community's performance standards.

In Wenger's (1998) analysis of insurance claims processors or Orr's (1996) studies of service technicians, small work groups or functional departments are seen as forming individual '*communities of practice*', individuals mutually bound by their engagement in a common enterprise and mastering a shared repertoire of skills (Lave and Wenger, 1991; Brown and Duguid, 1991, 1998; Wenger, 1998). Mutual engagement requires interaction and is therefore favored by geographical proximity. Many epistemic communities therefore cluster in specific regions, where the acquisition of their skills is favored by the presence of organizations providing appropriate learning opportunities (Håkanson, 2004). Examples include the engineers developing the technologies underlying the flat panel display industry (Murtha *et al.* 2001) or the communities concentrated in Silicon Valley (Brown and Duguid 2002; Saxenian 1996).

However, once the skills of the community have been acquired, mutual engagement does not necessarily require face-to-face interaction but can – "given the right context" – take place over the phone, by email or over the radio (Wenger 1998, p. 74). Indeed, most professional communities extend beyond individual organizations and localities. 'Normative isomorphism' through selection, socialization and vocational training leads to a professional…

> … pool of almost interchangeable individuals who occupy similar positions across a range of organizations and possess a similarity of orientation and disposition that may override variations in tradition and control that might otherwise shape organizational behavior. (DiMaggio and Powell 1983, p. 152)

Professional communities that span organizational boundaries create and legitimize common codes and cognitive frames. In the past, national borders often delimited communities and their practices (Kogut, 1991), but even before the advent of jet air travel and electronic communication geographical boundaries were not always important. Scientists, for example, have long formed loose but geographically extensive communities (Knorr-Cetina 1999). Common pursuit of a shared scientific practice allows their members to communicate and collaborate over large distances, without necessarily having close or frequent personal contact.

The semantic conventions in the inherited literature are ambiguous and it is useful, as Brown and Duguid (2001b) suggest, to distinguish such larger communities from the smaller work groups for which the term 'community of practice' was originally coined.[3] Following recent usage (Steinmueller 2000; Cowan *et al*. 2000; Edwards 2001), I propose to use the term '*epistemic community*' to denote groups of people mastering the tools, codes and theories of a common practice regardless of their geographical location and the intensity of mutual contact that they may maintain.[4] The expression '*community of practice'* will be used to signify groups, such as the functional departments of business

[3] Dougherty, following Douglas' (1987) retranslation of Fleck's (1935/1979) 'Denkkollektiv' ('thought-collective'), uses the term 'thought worlds' to denote the beliefs and perceptions common to members of functional departments. Boland and Tenkasi (1995) use the phrase 'communities of knowing', Bechky (2003a; 2003b) prefers 'occupational communities' while Grant (1996) and Carlile (2002) discuss 'expert knowledge' primarily in terms of business functions. Quoting the works of Strauss (1978, 1982, 1984) on 'social worlds', Knorr Cetina (1999) on 'epistemic cultures' and Ziman (1967) on 'public knowledge' in scientific communities, Brown and Duguid (2001b, p. 205) propose the term 'networks of practice.' The latter term has the advantage of emphasizing the instrumental aspects of knowledge: 'networks of practice', like 'communities of practice' develop over time in the common pursuit of a shared enterprise; they exist because they have a task to accomplish. On the other hand – as the authors note – the reference to 'networks' is potentially misleading in that it implies a certain regularity of contact that need not apply.

[4] According to Amin and Cohendet (2004, p. 74 ff.), the concept was first introduced by Knorr Cetina (1981) to denote groups of people involved in the deliberate production of knowledge, for example scientists in a particular field or the engineers of an R&D laboratory. It has also been employed in the field of international relations to denote communities whose members (1) share a common set of values and beliefs, (2) have common theoretical understanding regarding causalities regarding policy measures and desired outcomes, (3) have shared criteria for validity, and (4) pursue the same policy enterprise (Haas, 1992).

firms, pursuing common goals through common practices that involving more or less regular personal interaction.[5]

Epistemic Communities as Interpretation Systems

Epistemic communities form 'interpretation systems' (Daft and Weick 1984). They exist in order to help their members interpret the world and provide meaning to their activities. Their 'practice' is always (negotiated) social practice and includes both explicit and tacit components (Lave and Wenger, 1991; Wenger 1998). Epistemic communities are where knowledge resides and articulation and knowledge creation can take place.

Epistemic communities are defined and delineated by the generation and maintenance of shared *coding schemes* (vocabulary, codes) and *cognitive frames* (theories, mental maps) that help the community and its members define and solve problems and 'get the job done' (Håkanson, 2003). Communities are also characterized by their inherited technology, much of which is typically embedded in *physical artifacts* of various kinds.

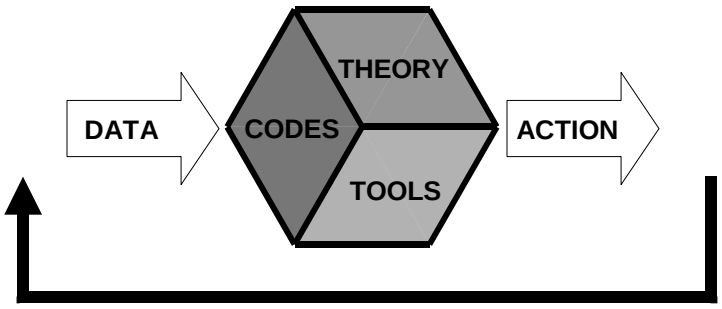

FIGURE 1. The Functional Elements of Epistemic Communities (adapted from Daft and Weick 1984).

[5] In some accounts (Amin and Cohendet, 2004, pp. 74-78), 'epistemic communities' are defined as communities of practice engaged in deliberate knowledge creation. However, for the present purpose, that distinction is not so important since – to various degrees – *all* communities of practice engage in learning and knowledge creation – both by deliberate intention and by accident (Lave and Wenger, 1991).

The capabilities of a community, i.e. the range and efficiency of the tasks it can perform, are determined by the dynamic interaction of these three elements, here labeled *codes*, *theory*, and *tools* (Figure 1). I use the concepts broadly. Thus 'codes' refer to all symbolic means, through which the community communicates with its environment and its members with one another, including both ordinary *language* and more specialized varieties, such as mathematics, chemical formulae or computer code – and *pictorial representations* (graphs, maps, diagrams and pictures, etc.).[6] 'Theory' refers to the *cognitive frames* that help it interpret and make sense of the messages.[7] It includes tacit cultural elements and '*mental maps'* but also formal *theoretical models* of the causalities deemed relevant to the practice. 'Tools', finally, is used to denote the *physical artifacts* that the community employs in the execution of its tasks or the development of its knowledge, including its physical "memory", i.e. the records and artifacts in which its experience has been codified or embodied and on which it can draw in performing its tasks.

Some codes, some theories and the use of some tools are generally learnt as part of a typical primary school curriculum, for example the rules and conventions of writing the local language and the skills of using a pencil. The mastery of others is specific to particular epistemic communities and is acquired through a combination of advanced general education, specialized training programs, apprenticeship or trial-and-error experiential learning in actual practice. They include both tacit elements and explicit cognitive schemata, ranging from simple rules of thumb to explicit scientific theory.

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[6] One of the things required of new members of a community is the mastery of the local language: "[K]nowing how to act within a domain of action is learning how to make competent use of the categories and the distinctions constituting that domain… [To] engage in collective work is to engage in a discursive practice, namely in the normative use of a sign system which is directed at influencing aspects of the world and whose key categories and distinctions are defined through their use in discourse" (Tsoukas and Vladimirou 2001, p. 978). However, as White (1990) has pointed out, effective use of language also requires (generally tacit) agreement as to what level of imprecision is acceptable: "Part of maintaining a community is maintaining the agreement not to speak or ask about the ways in which its language means differently to for different members. And those differences can be so enormous that in listening to the talk one is often surprised that it can go on at all." (White 1990, p. 36 in Weick 1995, p. 107)

[7] Cognition is the most socially-conditioned activity of man, and knowledge is the paramount social creation. The very structure of language presents a compelling philosophy characteristic of that community, and even a single word can represent a complex theory…. every epistemological theory is trivial that does not take the sociological dependence of all cognition into account in a fundamental and detailed manner." (Fleck 1935, p. 42 in Douglas 1987, p. 12)

KNOWLEDGE TRANSFER

For a considerable time, the organization and management literatures were dominated by a rather mechanistic model of language and communication, inspired by the pioneering work of Shannon and Weaver (1949). As summarized by Boland and Tenkasi, the associated 'conduit model' of communication suggests that …

> … communication can be improved by reducing noise in the channel, with noise defined as the possibility for error of contaminating the message on its route from sender to receiver. Noise can be reduced by increasing the channel capacity; by refining the procedures for encoding and decoding messages; by providing more reliable storage and retrieval facilities; or by making the channel of communication more universally available. (Boland and Tenkasi, 1995, p. 352)

This 'information processing' perspective of communication assumes the existence of shared codes and syntax and that the meanings to be conveyed can be expressed as codified messages. These assumptions have been all but abandoned in current literature, where a view of knowledge is often adopted, which emphasizes the importance of non-codified, 'tacit' knowledge over more explicit varieties.[8] 'Tacit knowledge', it is assumed, is 'sticky' and difficult to transfer; however, once it has been codified, there is nothing to prevent its rapid and near costless diffusion.

Although the possibilities and incentives to codify knowledge are frequently underestimated, the recognition that not all knowledge can be communicated in codified form is a valid and important one. However, the assumption that there are no barriers to the transfer and diffusion of codified knowledge is seriously misleading. It abstracts from the critical fact that meaningful transfer of even the simplest piece of information requires that the recipient masters the code in which it is expressed and can apply a theoretical frame relevant to its interpretation (Cohen and Levinthal, 1990; Lane and Lubatkin,

[8] Although their objectives and emphases differ, the parallel and overlapping theoretical developments of the 'knowledge-based' approach to the theory of the firm (Kogut and Zander 1992; 1993, 1996; Grant, 1996a, 1996b) and that of the 'resource-based view' on strategy (Wernerfelt, 1984; Barney, 1986; 1991, Peteraf, 1994) have been associated with a broad convergence regarding the way in which 'knowledge' – a central concept in both streams of literature – is conceived. Influenced by theoretical advancements in the sociology of knowledge and organizational theory (Lave & Wenger, 1991; Orr, 1996; Brown & Duguid, 1991; 1998), this consensus include basic assumptions as to the 'social' and 'path-dependent' nature of knowledge, the economic and strategic significance of 'tacit' as opposed to 'articulated' knowledge, the conditions favoring or obstructing the 'flow' of codified as compared to tacit knowledge, etc.

1998). It therefore ignores the problems associated with the mobilization, coordination and integration of specialized functional knowledge, as required in the operations of most organizations.

Conversely, the current emphasis on the situational and personal aspects of tacit knowledge has tended to obscure the fact that tacit knowledge can be 'shared' in the sense that people that have undergone the same experiential learning process will master the same tacit skills (Boisot, 1995; Sanchez, 1997). It therefore underestimates the potential for imitation and involuntary transfer of knowledge within epistemic communities.

While communication of knowledge between people belonging to the same community who share a common vocabulary, methods of practice and tacit skills is generally unproblematic, knowledge transfer between individuals belonging to different communities is often difficult, time consuming and expensive (Boland and Tenkasi, 1995). Fortunately, cooperation, coordination and joint action between the various occupational specialists of a firm do not require that each acquire the knowledge of the other. As Grant (1996a, p. 114) emphasizes, "… *transferring* knowledge is not an efficient approach to *integrating* knowledge." This is a key insight, the consequences of which will be elaborated below; a primary reason for the existence of firms is that they provide the means for knowledge integration and coordinated action without requiring people of different occupational backgrounds to share or understand each others' knowledge and world views.

Knowledge Transfer within Epistemic Communities

Members of the same epistemic community tend to have similar backgrounds in terms of formal training and job experience. They interpret their common practice in similar ways and share mastery of its tools. These commonalities are not limited to explicit aspects; engagement in the same practice provides similar types of experiential or tacit knowledge. In consequence, knowledge transfer between individual members of the same epistemic community can often be accomplished with relative ease regardless of their geographical location or organizational memberships (Figure 2). Indeed, within epistemic

communities, the communication of articulated knowledge rendered in standardized code can usefully be analyzed largely as an information processing problem, with emphasis on the existence of shared syntax (Boland and Tenkasi, 1995; Carlile, 2002).[9]

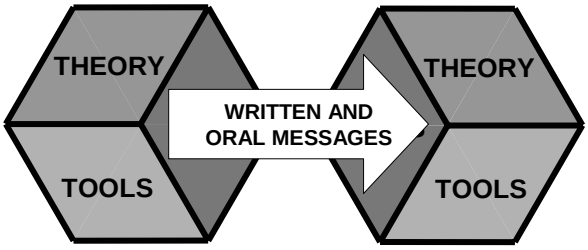

FIGURE 2. Transfer of Articulated Knowledge within Epistemic Communities

Whereas the transfer of codified knowledge within a community can take place with ease regardless of the distance between sender and receiver, tacit knowledge elements can only be acquired through personal experience, often over long periods. This generally requires some form of master-apprentice relationship or on-the-job training and is therefore dependent on geographical proximity between the learner and her master and/or place of work.

Although tacit knowledge is, by definition, rooted in the personal experience of the individual, members of the same epistemic community have been exposed to the same type of experience. The tacit knowledge that it provides is therefore not private but shared

[9] There is a caveat to this proposition: Differences in language and syntax exist not only *between* different epistemic communities but also *within* them, as local groups of practitioners develop idiosyncratic coding schemes (Allen 1977). These enhance the efficiency of communication among community members but impede communication with 'outsiders'. Like other aspects of organizational culture, local codes tend to be taken for granted and their mastery is largely tacit. Idiosyncratic codes frequently aggravate the problem of communication across organizational boundaries: "There is a great deal of overlap among the coding schemes of different organizations operating within the same culture. On the other hand, the nonoverlapping areas, however small, can potentially operate to produce semantic noise, and they can be even more troublesome because it can go undetected" (Allen 1977, p. 139). However, although oftentimes frustrating when they are encountered, the significance of these types of communication barriers should not be exaggerated.

within the community, whose members are sometimes geographically widely dispersed (Amin and Cohendet, 2004. Hence, even when the knowledge applied in the production of a particular artifact is highly tacit, this may not prevent its (perhaps involuntary) diffusion. Contrary to a common assumption, the ease of imitation is not so much dependent on the degree of articulation of the knowledge in question as on the extent to which the relevant epistemic community extends beyond the boundaries of individual firms or geographical localities. In many industries, also ones characterized by highly tacit knowledge and practices, the mere demonstration that a particular product design is feasible, as evidenced in a functioning physical product or other artifact, is sufficient to induce and permit rapid imitation (Figure 3).[10]

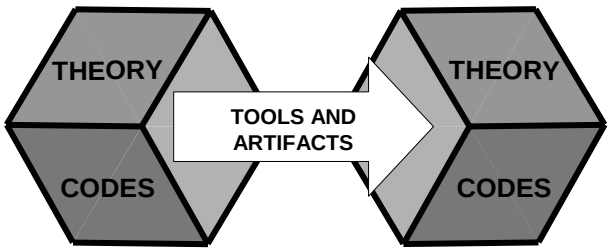

FIGURE 3. Transfer of Knowledge through Products, Machines and Other Artifacts

Being incidental to their primary purpose, the knowledge embodied in artifacts often has strong tacit elements.[11] Nevertheless, an observer belonging to the relevant epistemic community and versed in the appropriate practice can often through observation and reverse engineering 'decode' the artifact and lay bare the knowledge used in its design and production.

[10] Such imitation need not imply a one-to-one correspondence in capabilities. As Zander (1994, p. 22) notes, "... imitation does not require the exact copying of existing know-how... innovations can be introduced and manufactured in different ways."

[11] As most users of personal computers can testify, acquisition of an artifact can increase the capabilities of the acquirer also without transfer of the underlying cognitive elements. Indeed, in many instances, such understanding may be irrelevant for the user whose primary interest is the application of the artifact and who may be totally ignorant of the theoretical principles employed in its design and production.

Knowledge Transfer between Epistemic Communities

Within epistemic communities, codified knowledge can be communicated as 'information.' It is "...alienable from the person who wrote the code" and "...can be transmitted without loss of integrity once the syntactical rules required for deciphering it are known." (Kogut and Zander 1992, p. 386 f.) Transfer of codified information is unproblematic as long as the recipient is in possession of the code required to decipher the message and the theoretical frames that give it meaning. However, like the knowledge they express, many codes are specific to certain epistemic communities, reflecting the nature of their practice and their beliefs and values:[12]

> Scientific disciplines observe semantic traditions and meanings that vary between their respective contexts. Thus "…interpretation and understanding of scientific concepts is only possible by referring to the specific 'community' – together with the historical and sociological conditioning of that community – which has produced it." (Zolo 1989, p. 170 in Lane and Lubatkin 1998, p. 464)

The existence of an explicit and well-defined code does not by itself guarantee the efficient transfer of information. It also requires that the recipient be familiar with it and with the underlying theoretical perspective, which it expresses. If not, he/she must invest in learning the code of the message and the theory to which it refers. This requires conscious and costly effort and will only be undertaken if the perceived gain is high enough. Transfer of knowledge between epistemic communities is therefore cumbersome, expensive and prone to failure. This is evidenced not only by the overall dismal experience of technology transfer programs to developing countries; in the strategy literature, the same phenomenon is reflected in the important concept of 'absorptive capacity' (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998; Zahra and George, 2002).

[12] Already in the 19th century, the different practices and associated value systems of scientists and engineers were reflected in the codes employed. "In the physical sciences the highest prestige went to the most abstract and general – that is to the mathematical theorists from Newton to Einstein. Instrumentation and application generally ranked lowest. In the technological community the successful designer or builder ranked highest, the "mere" theorist the lowest… These values influence not only the status of occupational specialists, but the nature of the work done and the 'language' in which that work is expressed" (Layton 1971, pp. 576 ff.).

KNOWLEDGE INTEGRATION

The day-to-day operations of most firms would be hopelessly unmanageable if coordinated action between members of different occupations required that each acquire the knowledge of every other. Fortunately, this is not the case. Rules and directives, planned sequencing of activities and standard routines help firms economize on communication and knowledge transfer (Grant, 1996a, pp. 114 f.). Indeed, quite complex organizational routines operate on the simple basis that the output of some specialized activity provides the cue for the next to start (Nelson and Winter, 1982).

Even activities involving higher order forms of interdependence (Thompson, 1967), such as new product development and other unstructured problem solving, can be accomplished without the participants to the endeavor mastering the skills of one another. However, a mode of interaction must be established that permits knowledge of specialized communities to be *integrated* with one another (Grant, 1996a). As elaborated by Boland and Tenkasi (1995), mechanisms must be found that enable communities to overcome the degree of incommensurability of their specialized vocabularies, instruments and theories without sacrificing their respective integrity and distinctiveness. Successful knowledge integration is characterized by a "process of perspective taking in which the perspective of another can be taken into account as part of a community's way of knowing" (Boland and Tenkasi, 1995, p. 356).

The Role of 'Common Knowledge'

Knowledge integration does not take place in a void. As Grant (1996a, p. 115 f.) emphasizes, it depends on the existence of 'common knowledge,' including not only common language and mastery of basic symbolic means of expression (literacy, numeracy, familiarity with standard software, etc.), but also other shared meanings, mutual "recognition of individual knowledge domains" and awareness of available knowledge repertoires. The existence of a common knowledge infrastructure is an important prerequisite for efficient knowledge integration. Its strengthening through company-wide training programs and the nurturing of organizational cultures is an important means to increase the effectiveness of collaborative communication.

However, knowledge integration and 'perspective taking' – both routine activities (Bechky, 2003a, 2003b) and in infrequent and complex tasks, such as those associated with the development of new products (Carlile, 2002), – also rely on more specific mechanisms. In the literature, two main such mechanisms have been identified: *boundary-spanning individuals* and *boundary objects*.

Boundary-Spanning Individuals

'Boundary-spanning individuals' (Vincenti, 1990, p. 84), 'translators' (Brown & Duguid, 1998, p. 103) or 'knowledge brokers' (Wenger, 1998, p. 104 ff.) are individuals who belong to more than one community and who are therefore able to translate knowledge generated in one community into a form intelligible to the participants in another (Figure 4). These are typically people

> …who have themselves *moved* across the relevant inter-institutional, international, interfunctional or interdisciplinary divides, and thereby learned to think in the languages and cultures of the other side… It would be rare indeed to obtain the required knowledge, culture or language skills – say, simply by reading relevant cultural/linguistic grammars or guidebooks – without face-to-face personal interactions" (Hoch, 1990, p. 342).

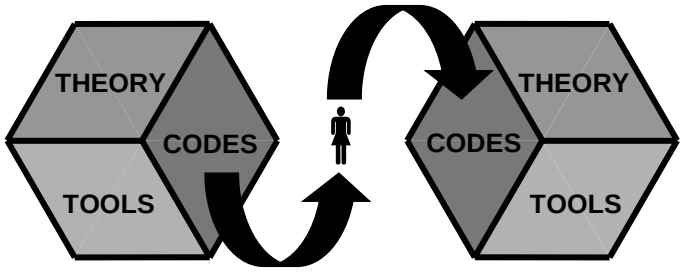

FIGURE 4. Knowledge Integration through Boundary-Spanning Individuals

However, 'deep' professional skills of this kind take a long time to develop, typically a decade or more and most people therefore acquire expertise only in one area (Simon, 1981). Hence, boundary-spanning individuals are in short supply and their employment can be quite costly.

Boundary Objects

But there are also less expensive ways of achieving coordination. Recent research has noted the importance of *boundary objects* (Carlile, 2002; Bechky, 2003; Star, 1989; 1993), i.e. "…objects that both inhabit several communities of practice and satisfy the informational requirements of each of them. In working practice, they are objects that are able both to across borders and maintain some sort of constant identity" (Bowker and Star 1999, p. 16) (Figure 5). They are significant because they facilitate coordinated action without requiring members of different communities to align their understanding of each other's knowledge:

> Perspective-taking is never a one-to-one mapping of meanings. Members of the same community of knowing will not have full consensus, and members of different communities cannot simply adopt the meaning of another. … [B]oundary objects do not convey unambiguous meaning, but have instead a sort of symbolic adequacy that enables conversation without enforcing commonly shared meanings. (Boland and Tenkasi, 1995, p. 362)

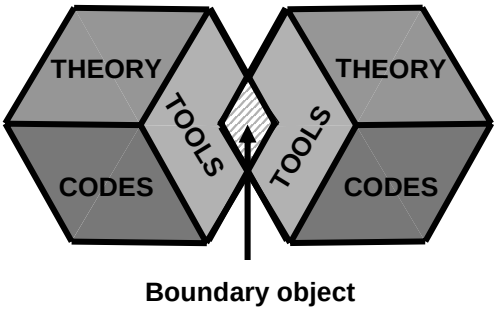

FIGURE 5. Knowledge Integration through Boundary Objects

Modern computer and information systems are pervasive examples of boundary objects. Their effects are important not only because they facilitate integration and new combinations of knowledge, but also because they create inducements to articulate knowledge in standardized code.[13] Many boundary objects benefit from simultaneous physical

[13] Kogut and Zander (2003, p. 513) relate the story of how a common CAD system acted as a catalyst in enabling a Swedish MNC to achieve the degree of global product standardization that its U.S. subsidiary had for almost a decade successfully resisted. (Probably to avoid offending the sensibilities of JIBS' American readership, Kogut and Zander portray the story as involving a French subsidiary – the French being notorious for their refusal to accept the wisdom of other nations, witness the country's position on the

manifestation. This is often the case with drawings, prototypes and physical products – probably the simplest, but commonest and most pervasive forms of boundary objects (Bechky, 2003a).

Not every artifact can function as a boundary object. Effective boundary objects, Carlile (2002) suggests, help overcome language barriers and differences in coding systems by facilitating the establishment of common syntax – often by way of simple physical demonstration ('show-how'). They also help overcome differences in theoretical perspectives by providing a means for individuals to express what they know as concretely as possible. If successful, boundary objects can help in the process of 'perspective taking', in which a community recognizes the expertise of another as an element of importance to its own practice. The process is often facilitated when a boundary object artifact or its representation can be physically transformed in response to negotiated changes in meaning.

KNOWLEDGE EXCHANGE AND GOVERNANCE

Firms consist of a multitude of epistemic communities, each with its own vocabulary, set of theories and tools (Brown and Duguid, 1991). This, as Amin and Cohendet, (2004, p. xiv) note, creates

> … a new governance problem… concerning how the division of work (which distributes functions and duties between actors) and the division of knowledge (which distributes the capacity of interpretation and learning between these actors) within firms can be aligned.

In order to achieve effective cooperation among its various communities and subcultures, firms need to undertake investments in boundary-spanning mechanisms.[14] These include

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war on Iraq.) While the story of the subsidiary's stubborn refusal to conform to a Swedish way of engineering is difficult to reconcile with the idea that "firms specialize in the internal transfer of tacit knowledge" (Kogut and Zander, 1993, p. 625), it does illustrate the vital role of boundary objects in bridging the epistemic communities of firms.

[14] Kogut and Zander (1996) suggest that 'identification' ensures that individuals act in line with the objectives of the firm. In contrast, the literature on the sociology of knowledge tends to assume that people identify more closely with the more specialized communities from which they derive their professional or occupational roles. In this case, it is the objective of the hierarchy to provide appropriate incentive schemes. Whatever the approach, however, a theory of the firm should attend not only to the *incentives* for cooperation but also the conditions that *enable* it to take place.

the establishment of an organizational infrastructure, including a broad area of common knowledge among members and a recognized delineation of occupational (and individual) knowledge domains (Bechky, 2003a). They also include the identification and employment of knowledge-spanning individuals and the establishment of boundary objects, both intentional ones, such as a budget and cost accounting system, and ones that are incidental to other purposes, e.g. drawings, prototypes and final products. These investments are specific to the context in which they take place and to the transactions that they facilitate and are therefore subject to the familiar risks of opportunism and hold-up (Williamson 1975; 1985). The need for such investments therefore determines the boundaries of the entrepreneurial firm (Alvarez and Barney, 2004) and influences also those of firms in later stages of development.

It is important to note that dedicated, firm-specific mechanisms for knowledge integration arise not from the 'tacitness' of the expertise employed but from the partial incommensurability of the knowledge entertained by the different epistemic communities, on whose joint efforts the activities of firms depend. There is no reason to assume that firms are more privileged in the integration of tacit knowledge than of more explicit varieties. Firms are institutions for integrating *both* tacit and explicit knowledge (Grant 1996a, 1996b).

Effort and investments in knowledge integrating mechanisms will only be undertaken in the expectation of benefits exceeding the associated costs. As Alvarez and Barney (2004) emphasize, the organization of rent generation must therefore be examined *simultaneously* with that of rent appropriation, an issue that resource-based theory has yet to effectively address. It is not a rare occurrence, for example, that a firm chooses to license its technology to a larger competitor whose existing marketing organization allows it to generate sales on a larger scale and more rapidly than the owner of the technology could.

Because of the associated uncertainty and ambiguity, the completion of agreements involving the sale of tacit or incompletely codified knowledge is difficult. The desire to

complete a licensing agreement therefore provides a powerful incentive to invest in the articulation and codification of the technologies involved. Technologies licensed to third parties are therefore, on average, more completely codified than those exploited internally.[15]

KNOWLEDGE BASED COMPETITIVE ADVANTAGE

The 'resource-based view' of strategy is based on the remarkably trivial observation that in order to do something successfully (such as staying in business), you need the skills to do whatever it is that you would like to do and you need to possess the physical resources necessary for the activity in question. In order to be more successful than others (earning above-normal profits), emulation of your skill by others and/or the acquisition of the required resources must be difficult. Following the influential conjecture by Winter (1987), much current literature has focused on the advantages conferred by skills based on 'tacit' knowledge which, it is now generally assumed, are difficult or impossible to imitate.

Implicit in this argument – although this is rarely spelled out – is the assumption that tacit knowledge in is both 'rare' and difficult to imitate. But as argued above, much tacit knowledge is common to all practitioners of a particular trade or occupation and is therefore not rare. Moreover, among such practitioners, new skills can often be emulated with relative ease. The 'absorptive capacity' possessed by members of an epistemic community of knowledge created by their peers is typically high. This helps to explain Zander's and Kogut's (1995) finding that the hazard of imitation of manufacturing technologies is independent of their degree of tacitness and supports their conclusion that "… the view of capability transfer and imitation as mirror phenomena needs to be refined. (p. 85).

[15] In an influential argument, Kogut and Zander (1993) suggested a causal relationship between a technology's degree of codification and the probability that its transfer to foreign countries will take place to a third party rather than to a wholly-owned subsidiary. In their empirical test of this hypothesis, the characteristics of a technology (i.e. its degree of tacitness) at the time of measurement (1989) is used to explain decisions regarding the mode of its foreign exploitation that were made, in some cases, two or three decades earlier. The argument advanced here implies a less unconventional concept of causality.

There may certainly be instances where the prevailing assumption regarding the imitability of tacit knowledge holds true. As a rule, however, competitive advantage is not created by the possession of tacit knowledge in individual functions or activities. It accrues to firms that manage to *integrate* the knowledge of their epistemic communities in a more efficient way than do their competitors. Such integrative capabilities are often both tacit and idiosyncratic to organizational context and are therefore difficult to imitate.

CONCLUSION

Firms gain competitive advantage, first, by accessing and nurturing the epistemic communities where critical knowledge is available or is being created, and, second, by their ability to integrate this knowledge with that of other communities (Teece, 1998). The question as to whether or not – or to what extent – knowledge has been codified into fixed, standardized form is only one aspect of its ease of dissemination. The members of epistemic communities master *both* the tacit and the explicit aspects of their practice. A richer understanding of the determinants and effects of (voluntary) replication and (involuntary) imitation requires that a distinction be made between the conditions that influence the knowledge integration *between* epistemic communities, on the one hand, and those that affect knowledge transfer *within* such communities, on the other.

Recognizing that the determinants and the costs of these different forms of knowledge exchange are fundamentally different throws important light on the existence and boundaries of firms: Firms exist because they have a relative advantage in the *integration* of diverse knowledge; superior such ability may confer competitive advantage because it is difficult to imitate.

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