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A configurational approach to the dynamics of firm level knowledge

Abstract

Purpose

Whilst there has been exponential growth in the work on the nature of organisational knowledge, relatively little progress has been made in terms of understanding the way in which knowledge specifically impacts on the firm. The aim of this paper is to further this understanding by developing a series of configurations representing some of the potential ways that knowledge is composed in organisations, with those components being tacit, explicit, architectural, component, individual and collective knowledge.

Design/methodology/approach

After a review of the literature we conceptually configure the extant understanding of knowledge over eight configurations. We illustrate each configuration with practical examples.

Findings

This configurational approach provides a basis for identifying potential complementarities and conflicts regarding the dynamics of organisational knowledge in competitive settings. It allows for a better understanding of knowledge in organisations and its link with competitive advantage.

Practical implications

Our argument can be used by managers to help them think of how knowledge is configured within their firm. By doing so they might better understand how this knowledge configuration might help them a competitive advantage.

Originality/value

This paper uses some traditional knowledge concepts but by proposing to take a configurational view of organisational knowledge we propose an original and meaningful way of examining the role of knowledge in the generation and sustainability of competitive advantage.

Keywords: Knowledge, Configuration, Competitive Advantage

Classification: Conceptual paper

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1. Introduction

How firms gain and sustain competitive advantage is the main concern of strategic management (Barney, 1986). The resource based view of the firm (RBV) literature, has heavily emphasised, amongst other characteristics, the potential of organisational knowledge to explain variation in the performance of firms, and from this, the generation of sustainable competitive advantage (Grant, 1996; Easterby-Smith *et al.*, 2008; Wernerfelt, 1984). In this view knowledge is the asset stock that underlies firm-level resources (Barney, 1991), competences (Hamel and Prahalad, 1994), and capabilities (Grant, 1991; Leonard-Barton, 1992; Penrose, 1959). The centrality of knowledge in the RBV had led to a knowledge based view (Conner, 1991; Conner and Prahalad, 1996; Grant, 1996; Kogut and Zander, 1992; Spender, 1996; Teece, 1998), which specifically argues that knowledge is the basis of sustained competitive advantage and the source of economic rents (Boisot, 1998; Barney, 1991; Grant, 1996; Teece, 1998). Hence it is also widely argued that knowledge furthers growth (Thorpe *et al.*, 2005), is the most important asset a firm can possess (Assudoni, 2005), and that competition is knowledge based (Lichtenthaler, 2005).

Despite the emergence of a plethora of research concerning the nature of knowledge, and its potential importance for organisations (Grant, 1996; Nonaka, 1991), relatively little progress has been made in terms of understanding the way knowledge specifically impacts on the firm, and the resulting implications for management and performance. The limited progress of research into organisational knowledge has, in part, been due to a heavy emphasis on investigating the

distinction between tacit and explicit knowledge in the RBV (Pinch *et al.*, 2003; Polanyi, 1966) or how knowledge can be captured (Dayan and Evans, 2006; Newell *et al.*, 2002; Nonaka and Takeuchi, 1995).

In this paper we aim to deal with this limitation by concentrating on the impact that various types and combinations of knowledge can have on firms. We do so firstly by exploring the concept of knowledge. It is important to do this as the 'knowledge field' suffers from a lack of cohesion in its definition and understanding across different disciplines. This creates difficulties in researching the subject and can stunt the development of the field, as comparisons across pieces of research, contexts or perspectives are difficult to make. We tackle this problem by defining six of the most commonly used and useful (in terms of facilitating an organisation to achieve a competitive advantage) descriptors of knowledge: tacit, explicit, individual, collective, architectural and component. We discuss these knowledge dimensions, explaining how they are characterised, the implications of this, and their firm level advantages and disadvantages. To fully understand these dimensions we also discuss them with regard to their position to the dynamics of knowledge: knowledge creation, imitation, and replication. Secondly we progress the extant literature by exploring some of the ways that knowledge can be configured. At present knowledge is predominantly considered in discrete categories. However to examine the impact of knowledge on the firm we argue that we should consider how various types of knowledge exist concurrently, and how these combinations of knowledge play different roles in a firm's ability to generate and sustain competitive advantage, as the interactions between the different knowledge dimensions result in the creation of different strategic assets. This is an important concern as Thorpe *et al.*, (2005, p.277) explain that "more studies...need to be conducted that conceptualize

knowledge differently, which focus on a more critical understanding of knowledge configuration” and because firms are “not a passive repository of knowledge”, as multiple types of knowledge interact and combine in varying ways (Assudoni, 2005, p.37). Since knowledge can be analysed to determine its position regarding the dimensions, viewing these dimensions as a series of configurations could be beneficial to firms, as many are concerned with how to manage knowledge effectively (Bryant, 2005). If managers are able to consider which configurations of knowledge exist in their firm, they can start envisaging the consequences in terms of complementarities or conflicts, and determine how their firm is most likely to gain a competitive advantage. To this end having explored the main dimensions of knowledge, we consider the implications of the knowledge configurations we identify for the firms ability to generate and sustain competitive advantage. To complement this we also describe the typical characteristics of a firm in each configuration and present an illustration. As the configurations have a prescriptive ability managers can determine which knowledge type they would find most useful in their firm and act to transform it accordingly.

2. Knowledge definitions and explanations

In this section we define the terminology used in the paper and explain the concepts employed in our subsequent discussions, which explore the different types of knowledge in detail.

2.1 Knowledge dimensions

The three dimensions we explore describe six different types of knowledge. These dimensions: tacit to explicit; individual to collective; and architectural to component,

have been drawn from the extant literature, and elicit a broad conceptualisation of organisational knowledge. The dimensions were selected as they are regularly referred to in the literature, and because many of the other dimensions we could have adopted cover similar ground, for example diffuse to concentrated, codified to uncoded (Boisot, 1983, 1998), simple to complex (Pinch *et al.*, 2003).

These three dimensions are not dichotomous categories, but instead can be understood as being positioned on a continuum (Pinch *et al.*, 2003). For example, as Polanyi (1966) explains tacit and explicit knowledge are inseparable, as tacit knowledge is an antecedent to explicit knowledge (see also Tsoukas, 1996). Spender (1994a, p.394), in his investigation into knowledge types, concluded that “these types of knowledge are not, of course, completely divorced from each other. The differences between them reflect our attempts to categorize knowledge which would otherwise appear to be seamless, endlessly interacting and embracing every element of human thought”.

These key dimensions of organisational knowledge are built from the various ways in which knowledge could be assessed or described (see figure 1). The tacit to explicit dimension is based upon the actual characteristics of the knowledge. It is concerned with whether the knowledge is difficult to express or not. The next dimension reflects where the knowledge is located, either within an individual person or within a group. Finally the component to architectural dimension indicates the focus of the knowledge, explaining whether it is specifically focused on a precise part of a product or process, or if it is overarching, encompassing the entirety of a system.

Insert Figure 1 about here

2.2 Dynamics of knowledge

Understanding how knowledge can generate advantage and who captures the rents generated from such knowledge are key issues when trying to comprehend how some firms outperform others, hence in the following section we consider the impact of the knowledge dimensions on the sustainability of competitive advantage. We examine the knowledge dimensions through three factors: knowledge creation, imitation and replication.

Knowledge creation is concerned with how firms sustain advantage through knowledge generation and innovation (Floyd and Wooldridge, 1999; Nonaka, 1994; Nonaka *et al.*, 2000). Nonaka and Takeuchi (1995) explain that the reason Japanese companies have been particularly successful and innovative is because they have been able to create organisational knowledge. They argue that new knowledge is created through sharing, exploitation or the interaction and combination of pre-existing knowledge (Gioia, 1986; Nonaka and Takeuchi, 1995; Simon, 1991). We come back to this point later in the paper.

There are many similarities between knowledge imitation and knowledge replication, as both are concerned with the extent to which knowledge is mobile, or can be traded. However, it is the context in which they take place that indicates the difference. Imitation is the transfer of knowledge externally, whereas replication is internal. Imitation relates to the extent that competitors find it difficult to copy knowledge, and hence reduce or eliminate a firm's advantage (Lippman and Rumelt, 1982; Reed and DeFillippi, 1990; Zander and Kogut, 1995). Liebeskind (1997) identifies three broad classes of mechanism used by firms to protect their knowledge from such appropriation: rules, compensation and structural isolation. Evidence suggests that oppressive rules controlling the movement of knowledge can create an

environment in which employees are unlikely to remain for long periods of time (Swayse, 1993). A mechanism more likely to have a positive influence on employee retention is the use of compensation to share the economic and psychological benefits of knowledge (Boisot and Griffiths, 1999; Liebeskind, 1997). Mechanisms such as bonus payments and equity stakes have often been used in circumstances where knowledge is concentrated in a group of key stakeholders (Jensen and Meckling, 1992). Similarly structural isolation (Liebeskind, 1997) via location or organisational separation, can be used to isolate particularly valuable areas of knowledge which the firm is trying to protect, such as the separation of Michelin's radial tyre operation in the 1960s (Liebeskind, 1997), and the Stealth Fighter development at Nellis Air Force base in the Nevada desert in the 1990s (Rich and Janos, 1994).

Whilst patents are often cited as a key mechanism for preventing the flow of knowledge to competitors (Teece, 1986), it is recognised that they can be ineffective due to either the prohibitive cost of enforcing the patent, or the opportunity for competitors to work around the patent once it has defined the explicit knowledge involved in its creation (Cohen *et al.*, 2000; Heller and Eisenberg, 1998; Lerner, 1995). For this reason patents may be suitable for simple, highly codified knowledge such as a chemical compound or mechanical device, but they become more problematic in highly complex and process oriented situations where there is greater ambiguity, and more opportunity, to find an equally effective alternative.

Similarly trade secrets allow the protection of highly codified knowledge which is not transparent through the sale or composition of the product, such as recipes or cosmetics (Teece, 1986). Such secrets require enforcing by stringent rules which may place strict processes and procedures onto employees (Rich and Janos, 1994).

However such rules can also bring significant costs, both in terms of the direct costs to operationalise the controls, and also with regard to the loss of knowledge generating opportunities which may be accrued from sharing knowledge with those outside the firm through “know-how trading” (von Hippel, 1987).

There may also be a concern over knowledge transfer when firms are working together, for example as a joint venture or alliance. Here the risk is one of unintended knowledge transfer, where one firm would acquire or understand more knowledge than the other firm wanted to give away or reveal (Norman, 2002). Again this would result in a loss of competitive advantage (Norman, 2002).

As mentioned above, replication is the transfer of knowledge internally within the firm, for example it concerns replicating ‘best practice’ procedures (Agrawal and Henderson, 2002; Hansen, 1999). Replication, as explained by Szulanski (1996), may, however, be difficult even between groups or departments belonging to the same organisation, as knowledge can be sticky, hence furthering an advantage based on these practices may not always be possible. Knowledge can be transferred throughout the organisation via both formal and informal processes, for example rules and procedures or face to face contact (Hansen *et al.*, 1999; Weick, 1995). The transfer is a simpler process when the one holding the knowledge and the intended receiver of it, have the same knowledge base in common (Lane and Lubatkin, 1998; Phelps *et al.*, 2007). Whether knowledge is subject to imitation or replication it will result in a firm having its competitive advantage undermined or enhanced (Reed and DeFillipi, 1990; King and Zeithaml, 2001).

3. Knowledge dimensions

3.1 Tacit to explicit knowledge

There is a widespread view that the most valuable resources are those with a high degree of tacit knowledge (Nonaka and Takeuchi, 1995; Leonard-Barton and Sensiper, 1998; von Krogh *et al.*, 2001). It was Polanyi (1966, p.4) who first defined tacit knowledge, explaining that “we can know more than we can tell”. Tacit knowledge is understood as a knowledge about how to do things, it is procedural (Ambrosini, 2002), related to action (Brockmann and Anthony, 2002), context specific (Polanyi, 1962), and not codified (Beamish and Armistead, 2001; Spender, 1994a). It has also been argued that the resources most likely to confer competitive advantage are those which are valuable in terms of their impact on the market, but which are hard for competitors to imitate in the medium term (Barney, 1995), these resources are predominantly tacit. This has led studies to focus on the distinction between tangible and intangible assets (Hall, 1993; Hall and Andriani, 1998), and on the surfacing of tacit knowledge as a key strategic activity (Ambrosini and Bowman, 2001; Eden *et al.*, 1979; Huff, 1990). Whilst it is recognised that all forms of organisational knowledge have a tacit component (Baumard, 1998; Sparrow, 1998; Tsoukas, 1996), and therefore tacit knowledge *per se* cannot be considered a distinctive property, research has continued to view tacit knowledge as imperative for achieving competitive advantage (McEvily and Chakravarthy, 2002; Ofek and Sarvery, 2001; Winter, 1987).

Tacit knowledge is not overly subject to imitability and easy transfer (Polanyi, 1962), hence if valuable it may be a source of sustained competitive advantage. One problem that managers may face with tacit knowledge is internal stickiness, whereby knowledge transfer to other areas of the organisation is difficult (Szulanski, 1996;

von Hippel, 1994). Tacit knowledge is also characterised by causal ambiguity, where the important aspects of knowledge are difficult to recognise or understand (King and Zeithaml, 2001; Reed and DeFillippi, 1990). However this does not mean it cannot be leveraged and copied, as over time it can be transferred without being made explicit when it is learned informally through observation in practice (Wagner and Sternberg, 1985), picked up through osmosis (Spender, 1996), personal interaction (Nonaka, 1994), or apprentice-like relationships (Nonaka and Takeuchi, 1995; Sobol and Lei, 1994), without the need for direct instruction (Brockmann and Anthony, 2002). As organisational circumstances change tacit knowledge may become obsolete and a core rigidity (Leonard-Barton, 1992), whereby the firm is inhibited from innovative behaviour because it is entrenched in the processes of its 'normal' operations. This can result in it being a source of dysfunctionality, because as it is often embedded in organisational routines and practices, it may take time for managers to recognise that tacit knowledge is hindering new knowledge creation or blocking adaptation to changes in the environment.

In contrast explicit knowledge refers to knowledge that can be structured, and therefore codified, into a series of categories, classifications (Boisot, 1983, 1998) or rules (Kogut and Zander, 1992; Nelson and Winter, 1982), which allow it to be more easily processed and communicated. Explicit knowledge is declarative, it can be communicated from its possessor to another person in symbolic form (Polanyi, 1962), and "the recipient of the communication becomes as much 'in the know' as the originator" (Winter, 1987, p.171). This suggests the knowledge can be readily "written down, encoded, explained, or understood" (Sobol and Lei, 1994, p.170). Codification facilitates and maximises the access and exploitation of knowledge, it allows knowledge to be stored where it can be retrieved and easily used, for

example formalised in processes and formulas or residing in databases or manuals (Hargadon and Sutton, 1997).

While tacit and explicit knowledge are different, according to Nonaka and Takeuchi's (1995) knowledge creation model, which they call the spiral of knowledge creation or SECI (Socialisation – Externalisation – Combination - Internalisation) model, knowledge creation is a dynamic process, with the creation of tacit and explicit knowledge being interrelated. They assert that tacit knowledge can be converted into explicit knowledge, and explicit into tacit. Socialisation involves the transfer of the tacit knowledge of one person to another. Externalization is the conversion of tacit into explicit knowledge through its articulation and systematization within the organisation. Combination relates to the transformation of explicit knowledge held by individuals and groups into explicit knowledge available to the organisation and the combination of extent explicit knowledge into new explicit knowledge. Finally internalization relates to the conversion of explicit knowledge into tacit knowledge, notably via individuals' learning by doing. This model suggests that organisations create knowledge through individuals and the interaction that takes place within the group (Bhalla and Lampel, 2007).

Generally speaking explicit knowledge is vulnerable to imitation (Winter, 1987). The implication is that the process of codification undermines competitive advantage as it presents knowledge in a way that is accessible, more easily understood and, therefore, more easily imitated by competitors (Badaracco, 1991). However, more positive aspects of this dimension suggest that codification is both an engine for growth, and the basis by which organisations can create particular standards in technological settings (Kogut and Zander, 1992). This is the notion of the "bandwagon effect" that relates to knowledge being transferred to other firms,

which then build up to a critical mass that results in benefits for all the firms involved (Abrahamson and Rosenkopf, 1993; Wade, 1995).

3.2 Individual to collective knowledge

Collective and individual knowledge are often utilised as a basic dimension for considering the nature of knowledge in organisations (Blackler, 1995; Spender, 1996).

Individual knowledge is widely accepted to be a valuable, intangible organisational asset, and felt to be a critical part of a firm's intellectual capital (Grant, 1996). Individual or personal knowledge can be clearly attributed to one person, it is knowledge owned by an individual. James (1950) and Polanyi (1962) both argue that all types of knowledge start with that which is individual. It is the main form of knowledge that exists (Camuffo and Comacchio, 2004). By definition knowledge is buried in the minds of individuals (Grant, 1996; Nonaka and Takeuchi, 1995). Hence new knowledge begins with the individual (Nonaka and Takeuchi, 1995), is then integrated with that which they already possess, and finally internalised to become one set of knowledge (Zarraga and Garcia-Falcon, 2003). Knowledge is adapted and internalised through a process of mental dialogues with oneself, and sharing with contextually relevant individuals or groups (Brockmann and Anthony, 2002; Brown and Duguid, 1991). With this dimension the knowledge is often tied to the person who created it (Hansen *et al.*, 1999), and therefore it is difficult for an organisation to monitor and control knowledge that has been internalised by an individual (Bhatt, 2002).

If an individual retains his/her knowledge, and does not share it, it will have very little impact on the knowledge base of the firm (Bhatt, 2002). To counter this

Nonaka (1994) and Nonaka and Takeuchi (1995) (as seen with the SECI model above) advise firms to facilitate interactions between employees, and encourage individuals to be mindful of external stimuli, with the objective being to amplify their knowledge and contribute it to the knowledge base of the organisation. Increasing the individual's awareness also delivers new perspectives to their own knowledge (Weick, 1978). Other mechanisms that have been reported as useful for transferring individual knowledge throughout an organisation are moving individuals to different teams (Hansen et al., 1999), or developing team learning to allow members to build and develop their individual knowledge.

Individual creativity and the sharing of knowledge throughout the firm or via work groups is part of the innovation process in most firms. In some organisations, notably small and medium sized enterprises, knowledge creation may essentially stem from one or two specific creative individuals. In many cases though, collective and individual knowledge combined is the source of knowledge creation. Knowledge is created through the social interactions and interchanges of individuals, and their exploitation of the knowledge currently residing in the firm (Nonaka and Takeuchi, 1995).

It can be suggested that an organisation which values individual knowledge is likely to have an uncoded approach to knowledge. Here knowledge is most likely to be shared informally, through personal contacts (Hansen, 1999). Competitive advantage based on individual knowledge is inherently precarious. This is because individual knowledge disappears if the individual holding the knowledge moves to another organisation (Boisot, 1998; Lam, 2000). As such this type of knowledge is easily lost, making the organisation vulnerable to the transfer of tacit, uncaptured knowledge to competitors because as "individuals come and go, they die off and

their tacit knowledge dies with them” (Boisot, 1998, p.38). If the knowledge has been codified in some form of repository such as a database, the individual’s knowledge can be accessed and used by others, and there is less of an impact on the firm’s performance (Hargadon and Sutton, 1997).

Conversely collective knowledge refers to knowledge that is shared across individuals and is readily available to anyone in the firm (Hansen *et al.*, 1999). Collective knowledge is not just shared individual knowledge (Spender, 1994b), “this goes far beyond the idea of knowledge being shared throughout the organization...Collective knowledge is a dynamic concept in that it is not only held collectively but also both generated and applied collectively” (Spender, 1994a, p.397). It is embedded in organisations, and stored in collective practices, routines and procedures (Spender, 1994, 1996). New employees to the organisation can quite quickly gain an understanding of this type of knowledge (Newell *et al.*, 2002).

Different reasons have been presented to explain the emergence of collective knowledge. Nelson and Winter (1982) argue that organisational practices require more knowledge than can be supplied by an individual, they believe that the firm develops routines to cope with these practices and that the routines create the collective knowledge. Spender (1994a, p.398) explains this further “organizations therefore remember by doing, and their doing is not completely understood by any of the members”.

However, Spender (1994a, p.399) also presents an alternative view for the development of collective knowledge which explains that, on their own, individuals cannot manage uncertainty, but instead need to be part of a “highly contextualized pattern of social activity”, the uncertainty is then dealt with via the collective knowledge of the social group. This view of collective knowledge is reinforced by

Durkheim's (1984) original work on the "conscience collective", which explained that each "society" has a collective way of thinking and acting. That collective knowledge and learning is embedded in the collective, subjective experiences and historical interactions of organizational members has also been reported by many authors (Daft and Weick, 1984; Dutton and Jackson, 1987; Spender, 1996; Weick, 1979).

To create, retain and gain access to collective knowledge the individual must be socially accepted and participative (Beamish and Arminstead, 2001). The spontaneous development of relationships between members over time builds the collective knowledge (Magnusson, 2004), which is then continually re-examined and reinterpreted by the social members (Raelin, 1997). Collective knowledge is internalised in the organisation through the informal interactions of employees (Bhatt, 1998). When employees interact they enrich their own knowledge and also contribute to collective knowledge, hence collective knowledge is not created by the individual employees, but as a result of their interactions (Bhatt, 2002).

Through relationships, mutual engagements, and the sharing of experiences and resources, collective knowledge and shared sensemaking is developed. Liebeskind (1997) differentiates between two types of collective knowledge, one as a shared routine to which each individual plays a pre-defined part, for example in a pit-stop at a motor race, and one as combined co-specialised knowledge, such as combinations of technical and market knowledge being united to create new product opportunities.

As described earlier collective knowledge is combined with individual knowledge, in new contexts and combinations to create new knowledge. It is the social interactions between groups or individuals that generate knowledge creation. This social process is underscored by Nonaka and Takeuchi (1995) who emphasise

it in their SECI model. They highlight the Socialisation and Externalisation parts of the model explaining that they are informed overtime by dialogue and interaction.

“Occasional contact between members of different departments...is not enough, they (Nonaka and Takeuchi, 1995) argue, because this does not allow for the sharing of tacit knowledge that is essential for knowledge creation. Instead, interactions must occur over a prolonged period within what they describe as an enabling context” (Newell *et al.*, 2002, p.49). This culminates to explain that knowledge is created as an outcome from interactions between diverse knowledge collections (Newell *et al.*, 2002; Nonaka and Takeuchi, 1995).

This social process to create and develop collective knowledge can hinder imitation and replication, because “such knowledge cannot be moved into an organisation without the transfer of clusters of individuals with established patterns of working together” (Teece, 2000, p.36). This means that a competitor could not imitate the knowledge without significant difficulties or costs. Whilst this is useful for the firm in terms of protecting its knowledge base, it can cause problems if it wants to replicate the collective knowledge in another area of the firm.

Finally while collective knowledge can be valuable to firms because of its embeddedness, it may also present a challenge to managers as it can be difficult to identify because it is not clearly attributable to any one individual. This means that collective knowledge can be vulnerable to managerial decisions that inadvertently damage critical knowledge, for example through layering or other forms of cost cutting.

3.3 Architectural to component knowledge

The concepts of architectural and component knowledge are drawn predominantly from the work of Henderson and Clark (1990), Miller and Shamsie (1996), and Matusik and Hill (1998). In a study of the semiconductor photolithographic equipment industry, Henderson and Clark (1990) considered the strategic implications of distinguishing between innovations created by either architectural or component knowledge.

Architectural knowledge is concerned with the entire production system. The knowledge is quite holistic in nature, as it centres around the compromises and compatibilities of the different elements of the system. Architectural knowledge is concerned with the influence and integration between elements and how they form a coherent whole, rather than any detailed knowledge of a specific component area (Henderson and Clark, 1990; Pinch *et al.*, 2003). Part of comprehending architectural knowledge is understanding how it operates as an organisational configuration (Henderson and Clark, 1990; Matusik and Hill, 1998); it connects and integrates the separate component knowledge aspects together to interact in a particular manner, so as to allow the organisation to function (Balogun and Jenkins, 2003; Finn and Waring, 2006; Howells, 2002; Tiwana, 2002). As such it is concerned with the organisation's routines, structure, systems, cultures, task distribution, relationships and communication channels (Balogun and Jenkins, 2003; Henderson and Clark, 1990; Pinch *et al.*, 2003; Richard and Devinney, 2005). These elements are embedded in organisations and routines over time, and their understanding of them becomes implicit (Richard and Devinney, 2005).

Once the dominant design or purpose of a firm is established the architectural knowledge becomes stable and embedded in the practices and procedures of the organisation (Henderson and Clark, 1990). If the firm does not have a dominant core

design it will continuously search for alternatives before selecting the most appropriate architecture (Henderson and Clark, 1990). Once the dominant design is established, the formal and informal communication channels develop around the interactions pertinent to achieving the firm's task; it is around these relationships that architectural knowledge is built (Henderson and Clark, 1990). Therefore architectural knowledge, because it lends itself to adopting set methods with which to solve difficulties, is perpetuated by the organisation only identifying and retaining information that is useful to performing its task (Arrow, 1974; Daft and Weick, 1984). Furthermore as architectural knowledge is usually path dependent, having a strong architectural knowledge base could actually harm an organisation, because it may be so focused on behaving in a specific manner that it is blinded to acquiring or absorbing knowledge from another firm (Pinch *et al.*, 2003). When confronted by a problem, alternative solutions will not be evaluated, but instead the architectural knowledge will present solutions which have previously been successful (Henderson and Clark, 1990), leading the organisation to rely on its old framework, and misjudge threats and opportunities. If a firm recognises that it should search for new solutions, it will have to rebuild its architectural knowledge. This can be difficult for employees, who have been used to operating in a specific manner (Henderson and Clark, 1990; Richard and Devinney, 2005).

It can be difficult for an organisation to operate if it has too many individuals who do not understand the architectural knowledge (Finn and Waring, 2006). For example new or temporary employees may initially only have access to the elements of architectural knowledge that are codifiable; knowledge of the more complex or tacit parts may take much longer to develop. This can have a significant impact on the effectiveness and integration of the organisation, which may be heightened

further if these individuals are also trying to learn component knowledge (Finn and Waring, 2006). The wider implications of this are that if new members are constantly introduced to a team that fulfils an important role in terms of architectural knowledge, the existing architectural knowledge may not have the opportunity to develop. However when new employees enter a firm in positions where they interact with architectural knowledge, their new ideas may meld with the extant knowledge in the firm, and the new architectural knowledge may be built into the firm's routines (Grossman, 2007).

New architectural knowledge requires the focus to be on novel and changing interfaces (Balogun and Jenkins, 2003) and not on the usual ways of working in the organisation, which may not be sufficient to overcome the new problems that it faces. Not all architectural knowledge has to be created in response to a crisis or problem, it can develop over time, in a more emergent manner, as individuals identify new ways of working (Finn and Waring, 2006). Conversely though the creation of architectural knowledge can be stymied if the firm is engaged in any outsourcing of its activities or operations as it may lose the architectural knowledge involved in these processes which disrupts its ability to embed this knowledge (Batchelor *et al.*, 2001).

In contrast component knowledge is concerned with the physically distinct aspect of the product that embodies a core design concept and performs a specific function (Clark, 1985). As it refers to the specific knowledge needed to create a particular element of a product, it tends to be specialised (Henderson and Clark, 1990). For example in the context of an organisation component knowledge could be identified as marketing, design or HR; these elements then come together as a cohesive operating organisation (Balogun and Jenkins, 2003). It is concerned with

identifiable parts of the organisation, not, as with architectural knowledge, the whole; therefore it will be items such as a specific resource or skill (Pinch *et al.*, 2003).

It might be assumed that component knowledge would be based on well codified explicit knowledge, for example an expert trained in a particular technology would be able to understand and potentially reverse-engineer the technology (Henderson and Clark, 1990). However it is also understood as intangible and tacit, due to the sometimes highly technical or expert nature of the highly focused knowledge (Pinch *et al.*, 2003).

Once a firm has established its dominant design then component knowledge can become more valuable than architectural knowledge (Henderson and Clark, 1990). This is because the firm competes on the basis of making alterations to the different components, hence its focus is to have sophisticated and comprehensive knowledge about all of the individual components of the dominant design, within a framework of stable architectural knowledge (Clark, 1985; Dosi, 1982; Henderson and Clark, 1990).

As component knowledge is context specific and transparent to specific individuals (McCaughey, 2002), it is often thought to be transferable (Pinch *et al.*, 2003). Competitors may seek to imitate a firm by accessing its expert skill by poaching its employees who hold component knowledge. However if the poached employees do not hold architectural knowledge it would be difficult for them to quickly embed this knowledge in to the competitors organisation. Although in those competitor organisations that did have quite similar architectural knowledge the component knowledge would be relatively easy to transfer (Pinch *et al.*, 2003).

A problem with replicating component knowledge is that whilst an organisation may be able to develop highly specific technical know-how, this know-how may have

been created by a small group, therefore attempts to shift the knowledge, for example from research to manufacturing or marketing could be met with major problems, because of a failure to understand the different coding schemes (Dougherty, 1992). An awareness of these issues has led some organisations to develop methods to facilitate knowledge dissemination, for instance it is the role of some individuals, known as “boundary spanners”, to take knowledge coded by one group and assist in translating it into another context (Allen and Cohen, 1969; Tushman, 1977). These individuals can be especially useful if the knowledge is complex (Arora *et al.*, 2001; Caves *et al.*, 1983; Gambardella, 2002), or imperfectly understood (Arora *et al.*, 2001). Another means of knowledge dissemination is information systems, where large databases are created to facilitate communication across geographically dispersed employees or other boundaries.

This section has presented a discussion of the characteristics of six types of knowledge and their relationships with the dynamics of knowledge, across three dimensions. In doing so it has discussed the strategic implications for the firm, and therefore given a rich understanding of the different knowledge types.

In table 1 we now summarise our discussions of the six knowledge types, showing their characteristics, and advantages and disadvantages pertaining to the dynamics of knowledge.

Insert Table 1 about here

4. Knowledge configurations

In the previous sections we defined the three main knowledge dimensions, envisaged their strategic imperfections and identified the affects on competitive advantage in organisations. In what follows we combine the dimensions of

knowledge to form a series of knowledge configurations. The reason for this, as explained earlier, is because it is limiting to describe knowledge by only one facet, as any piece of knowledge needs to be understood by its characteristics, location and focus; ergo the dimensions combined. Furthermore an organisation that configures, for example explicit and component knowledge will not have the same strategic agenda as an organisation that is bound by individual and architectural knowledge. An organisation's approach to outperforming its competitors, or addressing a key goal of strategy (Barney and Arikan, 2002), is unlikely to be the same.

The value of using configurations (or gestalts, archetypes or generic types as they are also known (Miller, 1986)) to develop an area of empirical interest, has been outlined by Miller and colleagues (Miller, 1981, 1986, 1996; Miller and Friesen, 1984; Miller and Mintzberg, 1984). The purpose of configurations is so that a number of variables can be appraised whilst maintaining a "meaningful and coherent slice of organizational reality" and giving holistic order to a subject (Miller, 1981, p.8). Miller (1981, p.3) explains that configurations "have tightly interdependent and mutually supportive parts, the significance of which can best be understood by making reference to the whole". Therefore the different dimensions comprising the configuration are better understood and give depth when in context with the other elements, and the entirety of the configuration. Our derived configurations reflect this as the dimensions stem from the same base; knowledge. Hence they are interdependent, but give a richer, more detailed understanding of the subject by viewing the elements in unison. This means that although each configuration is different they are understood across related features. The configurations themselves depict a "common alignment of elements...(via)...complex systems of

interdependency brought about by central orchestrating themes” (Miller, 1996, p.506).

The use of configurations also has a predictive ability, as, in this context, an organisation can use the differing views of knowledge as a mechanism to see where it currently lies, and also to determine where it may strive to position itself in the future. To illustrate this a firm’s current knowledge configuration could hinder it from achieving its future strategies, for example a small family run business will have different knowledge capabilities and needs, in comparison to a more entrepreneurial growth orientated, investor driven, start up business. This is an important understanding for an organisation to gain as Miller (1996, p.510) explains that a configuration would be a “greater source of competitive advantage than (in comparison to) any single aspect of strategy”. Miller (1986) also explains that as organizations are complex, configurations encompassing multiple elements bring an understanding to this complexity. They help the understanding of “large amounts of complex, voluminous data” (Phelps *et al.*, 2007, p.2-3).

The combination of the three knowledge dimensions generated eight possible configurations. These combinations of knowledge in organisations are listed and their key characteristics are also summarised.

Insert Table 2 about here

5. Knowledge configurations and their strategic implications

The purpose of the knowledge configurations is to gain a better understanding of how knowledge can be related to the strategic agenda of organisations, and be used to identify an organisation’s rent generating potential. In this section we consider the resulting interactions of the eight configurations, given the discussions regarding the

different knowledge types, on the creation of knowledge, its imitability or replication, and its appropriation¹.

In general it would be expected that with the configurations which are comprised of an explicit dimension (A, B, C, D), an organisation would need to introduce protective mechanisms to ensure knowledge remains within the firm and does not get easily imitated as these protections are not inherent to the knowledge configurations *per se*. Comparatively in the configurations where knowledge is less likely to be lost, such as those related to tacit knowledge (E, F, G, H), the organisational mechanisms are more likely to focus on engendering knowledge creation to ensure that these areas do not suffer from core rigidities (Leonard-Barton, 1992).

5.1 Configuration A: *Explicit/Collective/Architectural*

Configuration A reflects knowledge in organisations as created predominantly by forming knowledge objects (e.g. a report or document). In this configuration there are organisational norms that encourage individuals to embed their knowledge into formal systems such as databases and intranets; hence it may be easily imitated by competitors (Boisot and Griffiths, 1999). To prevent knowledge from leaking out to competitors, the firm will strictly enforce rules and legal controls, however this may be difficult to maintain as it is widely recognised and understood throughout the organisation. As knowledge is highly explicit such breaches are more easily defined and enforced.

¹ As the knowledge configurations are devised from the singular knowledge dimensions we have decided, for the sake of parsimony, not to repeat the list of references.

Configuration A is best exemplified as a consultancy. These firms are focused on the codification of knowledge and view it as a clearly defined entity. The consultancy can see the usefulness of individuals, but it is collective knowledge that is predominantly valued. The firms invest heavily into databases, intranets and communication systems, as they want to lessen the risk of individuals leaving with significant pieces of knowledge, hence they reward them for submitting information into these knowledge repositories. Firms want knowledge to be accessed and permeate throughout their divisions, around their entire global operations. This is exemplified in a quotation from an Ernst and Young Director “After removing client sensitive information, we develop ‘knowledge objects’ by pulling key pieces of knowledge such as interview guides, work schedules, benchmark data and market segmentation analysis out of documents and storing (them) in the electronic repository for people to use.” (Hansen *et al.*, 1999, p.323).

5.2 Configuration B: Explicit/Collective/Component

With Configuration B the key areas of knowledge are bounded and created by formal systems. Knowledge is easily moved within a concentrated group of knowledge workers. However its highly explicit nature makes it relatively easy to move knowledge outside of the group. This can also lead to the generation of general ‘best practice’ techniques throughout the firm. Knowledge is quite easily plotted within the firm, so employees know which collectives to access specific knowledge sets from. Knowledge replication is dependent on recognising the codification practices necessary to define and structure the knowledge. The collective and concentrated nature of the knowledge makes imitation quite challenging. In order to prevent

knowledge from leaking to competitors, the knowledge is again bound by strictly enforced rules and legal controls.

An example of configuration B could be found in a firm that was structured on a functional basis. Employees in the firm all have an awareness of who to ask for specific knowledge. So for example in the development of a product, the team lead would be able to seek out marketing or manufacturing information from the requisite departments. Although a competitive advantage can be created, it is only likely to have a short level of sustainability as it is built around a specific task. The competitive advantage is developed on the basis of the dynamic problem solving that can take place because this type of knowledge allows for, and results in, swift learning as problems can be quickly answered due to specialised knowledge.

5.3 Configuration C: Explicit/Individual/Architectural

Knowledge is created, in Configuration C, through individual experience. It flows by formal communication through individuals who understand the taken for granted system of how the organisation works across the firm and are able to verbalise this knowledge. This means the configuration is particularly vulnerable to the loss of the key individuals who know and understand the firm's routines. Hence, the individual focus means that mobility is a key problem, as individuals may well leave the firm, to set up their own firms and become competitors. This means that compensation approaches and structural isolation, supported by rules and legal controls, are necessary, otherwise firms deploying such a configuration may well only have a temporary advantage.

Some dot.com or software start up firms experienced this when key organisational members created replica companies. When isolation mechanisms are

not put in place incumbent firms often have little option but to go to court to stop the competition, however this does not often work as it was the responsibility of the incumbent firm to have restrictive covenants or confidentiality agreements in the employees contract. Khoja (2006) reports of such a case where a key employee, a former salesman Mitch Tunnard, resigned from Helmet Integrated Systems Limited, and established himself as a competitor in Modular Helmet Systems Limited.

5.4 Configuration D: Explicit/Individual/Component

In Configuration D knowledge is created through individual experience. It is transferred amongst a concentrated group of employees via formal communication. Although the knowledge is not of a specialist or expert nature, the individuals will work in specialisms that will not be completely understood by others. The component nature of knowledge in this configuration makes its flow across boundaries less problematic; however it is vulnerable to the loss of individuals. Furthermore, as with Configuration C, there is the need to achieve a balance between a rule/controls regime and allowing individuals the scope for greater satisfaction and commitment to their organisation via compensation schemes.

For configuration D, a factory line offers the most appropriate example. The understanding of an activity, for example order fulfilment, will have a number of discrete parts to it, such as, simplistically: acknowledgment of order, picking, packing and postage. Each employee will fulfil their role based on the knowledge they received via formal training or procedures, which will also develop the longer they remain in the position. In this configuration creating a competitive advantage may be difficult. The only way is probably an efficiency improvement, which would allow the factory to reduce its production cost and hence allow it to pursue a low cost strategy (Porter, 1980).

5.5 Configuration E: Tacit/Collective/Component

In Configuration E the interchange between individuals in practice and group problem solving leads to the creation of knowledge. Similarly practice and experience also escalates knowledge transfer. This knowledge is not characterised by organisational types, but rather is likely to be embedded in communities of

practice beyond the firm (Brown and Duguid, 1991; Lave and Wenger, 1991), therefore access to knowledge is achieved through developing similar communities in competitive firms. Here knowledge is less susceptible to leakage, because even if individuals leave an organisation the knowledge is unlikely to move with them as it is held by the collective. This is reinforced by individual compensation, the importance of supporting “professional” satisfaction, and enabling the development of communities within the firm.

Collective knowledge has also been found to reside in communities of practice (Brown and Duguid, 1991; Lave and Wenger, 1991). Brown and Duguid’s (1991) research emphasised the interdependencies of creating and transferring knowledge around a community of practice. They purport that formal and informal groups in firms share a common understanding in working practices, interpretations and perspective, which may have developed from the history and routines of the community. Their research also reaffirms that much of the transfer of this type of knowledge is dependent on a social aspect (Lave and Wenger, 1991). As a hub of collective knowledge the community of practice comprises networks of people who share knowledge needs and interests (Brown and Duguid, 1991), it is understood to allow individual autonomy, but is maintained by a language common to those in the organisation (Zarraga and Garcia-Falcon, 2003). Other research has identified that these communities have a shared perspective, contribute to and utilise the collective knowledge, and operate in a shared repertoire (Magnusson, 2004).

A clear example of a community can be seen in Configuration E with specialist scientists or the doctors in a hospital, who will have a stronger knowledge affinity with their doctor colleagues internally and externally than with any other member of staff at the hospital. It is in this collective that the knowledge is created,

predominantly through the solving of problems, and to stimulate social recognition. Over long periods of time and many interactions the knowledge develops, this can lead to a sustainable competitive advantage which competitors may find hard to imitate or destroy, because of the lengthy and complex manner in which it has been created. This competitive advantage, whilst strong, is able to be further nurtured by the firm if it supports this community well and recognises the input their knowledge makes.

5.6 Configuration F: Tacit/Collective/Architectural

Knowledge creation in Configuration F is dependent on the embedded culture within a firm. It is characterised by strong assumptions concerning the nature of knowledge which may result in the creation of core rigidities (Leonard-Barton, 1992). The transfer of knowledge is based on shared understandings and recognition of knowledge across the firm. Knowledge in this configuration is difficult to imitate due to its strong collective nature. In its role integrating component knowledge, architectural knowledge is based on social interaction, hence it is theorised to have a strong relationship with tacit knowledge (Matusik and Hill, 1998).

Configuration F is quite similar in characteristic to configuration E, we illustrate this configuration with a Rugby Club. Here the entire team are bound by a strong culture, which lets them develop their knowledge collectively. Although the rugby players are all skilled at individual positions they have a collective knowledge of “the big picture”, they all understand how each player’s position works with the other positions, and how they operate as a unit. It is this understanding at the team level that brings the competitive advantage, which will be highly sustainable due to the long and integrated way that knowledge is created between the team members.

5.7 Configuration G: Tacit/Individual/Component

With Configuration G the individual experience amongst key employees leads to the creation of knowledge. Its transfer is through close interactions and learning of a concentrated group of individuals. Transfer of knowledge across the firm is generally problematic. Knowledge imitation in this configuration is normally achieved through the recruitment of key individuals by competitors. The structure of knowledge in this context makes tight regimes difficult, and so compensation and 'buy-in' of key individuals is often essential. The knowledge is transferred via master-apprentice style relationships, and may happen over a number of years.

The CEO, or other specialised top team position in a firm, characterises configuration G. This configuration has the most risk associated with its knowledge because once the individual leaves the firm the knowledge is lost. However the individual knowledge can lead to a very sustainable competitive advantage, and if the firm offers the right compensation to the individuals it may retain them for a long time. These individuals are regarded as 'experts' in their field, and a team of them, each with their own individual specialised skills may successfully run a firm for numerous years. The individuals generate knowledge from their understanding of their own specific specialism, for example knowledge of a market. These individuals do not necessarily need to be at the top of an organisation and could be in very specialised positions, for example a football manager such as Manchester United's Sir Alex Ferguson.

In his strategy textbook Grant (2002, p.9) narrates the success story of Ferguson, explaining that he built his career progressively and "his life has been built around the exhilaration of winning and the dread of losing". He also emphasises that

his strength as a coach is to have been able to create a team with a single spirit, a fully integrated team. He has done so through his ability to select outstanding players, and nurture, develop and motivate them. This ability as a coach has developed through time, through his experience with other teams, the insights he gained and his constant commitment to success. Although other managers attempt to imitate Ferguson's way of operating, their efforts are not usually so fruitful. This type of knowledge configuration can be very valuable, but it is also extremely vulnerable as Ferguson could leave for another club or retire completely. The focus for Manchester United should be to capture Ferguson's know-how through the possible use of an 'apprenticeship' relationship with a potential successor.

5.8 Configuration H: Tacit/Individual/Architectural

Finally in Configuration H knowledge is created through individual experience. The transfer of this knowledge is through close interactions of individuals across the firm, and as such it is often associated with smaller organisations. Imitation of knowledge in this configuration is normally achieved through recruitment of individuals by competitors. For the appropriation of knowledge individual buy-in is critical, but it also requires some form of structural isolation to maximise its efforts.

In this illustration the final configuration, H, could be a bakery, but it could be exemplified by any small firm. Here knowledge is generated via immersion in the process and the individual interaction with it. Competitive advantage may be sustained as the skill and knowledge creation and transfer process would occur over a long period of time. However as with configuration G, the individual can be recruited, or in this instance may set up their own establishment, for example the apprentice may open a bakery in competition with the master he learnt from. At this

point the knowledge is still architectural, but as the organisation grows it may need to become component based to cope, here the competitive advantage opportunities in the firm will alter.

5.9 Discussion and Conclusion

This paper has explored six of the most commonly used types of knowledge, and related their position to the dynamics of knowledge. We then progressed the extant literature by investigating knowledge by considering the way it configures, so as to bring a different conceptualisation to the discipline and a practical tool for managers when considering their own firm.

The identification of a typical firm for each knowledge configuration has two useful and practical applications. Having access to this sort of understanding would enable managers to determine what type of knowledge was prevalent in their firms, this would allow them to better understand the knowledge, and identify how it may be possible to gain a competitive advantage. Furthermore it also has a prescriptive ability as it shows managers what type of knowledge they need to operationalise for their firms future strategies. For example a firm operating as configuration E, may realise, from where it wants to grow to and what its strategic aims are, that it needs to move its knowledge base to be as in configuration F.

Of course it is perfectly feasible that a firm may find it has several configurations all operating at the same time, for example a pharmaceutical firm could have a CEO (G), specialist scientists (E), a functional split for marketing, sales, etc. (B), and a factory production line making the pharmaceuticals (D). In this instance it is important for the firm to understand where its greatest opportunities for developing a competitive advantage lie, and which areas, albeit with their own

knowledge base, will not develop a real knowledge based advantage. It is in developing this knowledge based view of the firm that an organisation can identify where its most sustainable opportunities are and how best to use the other resources it holds to support them.

The management agenda therefore becomes the implementation of a highly tuned balancing act between enhancing the creation and transference of knowledge within the organisation and protecting the loss of knowledge beyond the organisation. We posit that such balancing acts are highly contingent on the characteristics of knowledge within the organisation and that knowledge strategies need to be highly sensitised to the contextual factors and strategic choices which characterise particular organisations. We suggest that it is this fine grained appreciation of knowledge characteristics which will not only enable us to explore the relationships between organisational knowledge and performance, but will also operationalise empirical frameworks to begin to unpack some of these important distinctions.

Finally to conclude we can make some suggestions for future research. As noted by many authors (see for example Aragon-Correa and Sharma, 2003) the challenge of any conceptual research is to develop empirical measures. We believe this is the next logical step for the ideas set out in this paper. We propose that the eight configurations could be researched empirically to find evidence to give greater depth and allow for a richer understanding of the concepts. This could be accomplished by conducting field research to determine the extent of the presence of our theoretical constructs. This would also allow us to better understand in context the choices in terms of knowledge configuration organisations face overtime and how and whether they can move from configuration to another.

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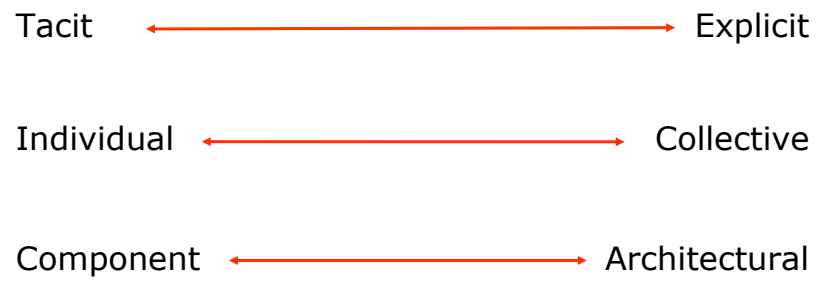
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Figure 1: The three key dimensions of organisational knowledge



Type of knowledge	Characteristics	Firm level advantage	Firm level disadvantage
Tacit	<ul style="list-style-type: none"> • Individuals know more than they can tell (Polanyi, 1966). • It is knowledge about how to do things (Ambrosini, 2002). • All forms of knowledge have a tacit component (Tsoukas, 1996; Baumard, 1998; Sparrow, 1998). • Tacit knowledge is context specific, personal, uncoded, complex, ambiguous, dynamic and procedural (Polanyi, 1962; Spender, 1994a; Beamish and Armistead, 2001). • It is communicated by activity, or understood via osmosis, participation or observation (Spender, 1994a; Nonaka and Takeuchi, 1995; Beamish and Armistead, 2001). 	<ul style="list-style-type: none"> • Difficult for competitors to imitate. • It is rooted in an individual's action and experience, and is attached to the knower, so it does not lend itself to capture (Nonaka and Takeuchi, 1995; Ambrosini, 2002). • Embedded in non-prescribed routines and practices which are often taken-for-granted and not readily discussed (Nelson and Winter, 1982). • Sticky. • Difficult to transfer. 	<ul style="list-style-type: none"> • It does not lend itself to capture (Polanyi, 1962). • Due to "internal stickiness" it is difficult to transfer to other areas in the firm (von Hippel, 1994; Szulanski, 1996). • If an individual leaves a firm, they take the tacit knowledge with them. • Embedded (Nelson and Winter, 1982). • Causally ambiguous (Reed and DeFillippi, 1990; Wilcox King and Zeithaml, 2001). • It can become a core rigidity, and be a source of dysfunctionality, as it is often embedded in routines and practices, it may take time to

			recognise that it can hinder knowledge creation or block adaptation to changes in the environment (Leonard-Barton, 1992).
Explicit	<ul style="list-style-type: none"> • It can be readily written down, encoded, explained, and understood (Sobol and Lei, 1994). • It is structured, and codified into a series of categories, classifications or rules which allow it to be easily processed and communicated (Nelson and Winter, 1982; Boisot, 1983, 1998; Kogut and Zander, 1992). • It is declarative, and can be communicated to another person in symbolic form, with the recipient becoming as much 'in the know' as the originator 	<ul style="list-style-type: none"> • Engine for growth, via build up of critical mass with other firms (Kogut and Zander, 1992; Abrahamson and Rosenkopf, 1993; Wade, 1995). Patents are used to prevent the flow of knowledge to competitors, especially for simple, highly codified knowledge. • Trade secrets protect highly codified knowledge, i.e. recipes or cosmetics (Teece, 1986). • Everyone in the firm can access the knowledge, which may then spark new ideas. 	<ul style="list-style-type: none"> • Knowledge management projects capture, codify and store explicit knowledge; as such the knowledge can be very transparent (Kogut and Zander, 1992). • Subject to imitation. • Transfer across and beyond the boundaries of a firm. • Patents can be ineffective due to enforcement cost or the opportunity for competitors to work around the patent once it has defined the explicit knowledge for its creation (Lerner, 1995; Heller and

	(Polanyi, 1962; Winter, 1987).		<p>Eisenberg, 1998; Cohen et al., 2000).</p> <ul style="list-style-type: none"> • Trade secrets require enforcing by rules and strict processes (Rich and Janos, 1994). They can incur operational costs and the loss of knowledge generating opportunities from sharing knowledge with those outside the firm through “know-how trading” (Von Hippel, 1987).
Individual	<ul style="list-style-type: none"> • Clearly attributed to one person. • Owned and tied to the individual who created it (Hansen et al., 1999). • A critical part of a firm’s intellectual capital (Grant, 1996). • Difficult to monitor and control knowledge that has been internalised by an individual. 	<ul style="list-style-type: none"> • Shared informally, through personal contacts (Hansen, 1999). • Difficult for competitors to imitate. • Difficult to transfer outside of the firm. 	<ul style="list-style-type: none"> • Difficult to transfer knowledge around the firm. • If the individual leaves the firm, then the knowledge they have goes with them (Boisot, 1998). • Difficult to capture or appropriate benefits from the knowledge (Bhatt, 2002).

Collective	<ul style="list-style-type: none"> • Knowledge shared across groups or the firm as a whole, readily available to those members (Hansen et al., 1999). • Embedded and stored in collective practices, routines and procedures (Spender, 1994, 1996). • New employees can quickly gain an understanding of this type of knowledge (Newell et al., 2002). • Collective knowledge is internalised through the informal interactions of employees (Bhatt, 1998). 	<ul style="list-style-type: none"> • Create new knowledge and transfer it around a community (of practice) (Brown and Duguid, 1991; Lave and Wenger, 1991). • Codification may be formal, via established rules, procedures and standards, or informal and embedded in firm routines and sensemaking (Weick, 1995). • Knowledge is not lost as easily as individual knowledge, as an entire group would have to leave the firm for knowledge to be lost completely (Teece, 2000). • Embedded. • Created and developed through the social interaction of individuals (Weick, 1979; Daft and Weick, 1984; Dutton and Jackson, 1987; Lave and Wenger, 1991; Spender, 1994a; 	<ul style="list-style-type: none"> • Subject to imitation. • Sticky information and problems of replicating best practice stem from difficulties in transferring knowledge in the firm (von Hippel, 1994; Szulanski, 1996). • Codified knowledge can exist and is embedded in pockets in the firm, so knowledge is readily understood in particular groups, but not recognised or understood if transferred to another part of the firm. • Difficult to identify, as it is not clearly attributable to an individual. So it is vulnerable to managerial decisions that can inadvertently damage critical knowledge.
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		1996; Raelin, 1997; Beamish and Arminstead, 2001).	
Architectural	<ul style="list-style-type: none"> • Interested in the compromises and compatibilities between different elements of the system; it is more holistic in nature (Henderson and Clark, 1990). 	<ul style="list-style-type: none"> • Allows the firm to organise its purpose and knowledge to make connections around the firm. 	<ul style="list-style-type: none"> • Vulnerable to imitation, as its wide understanding and availability make it visible to competition.
Component	<ul style="list-style-type: none"> • Refers to the specific knowledge needed to create a particular element, it tends to be specialised and technical. (Clark, 1985; Henderson and Clark, 1990). • Often characterised by clusters of expertise. 	<ul style="list-style-type: none"> • Develops particular areas of expertise to complete tasks undertaken by the firm. 	<ul style="list-style-type: none"> • Subject to imitation • The highly specific knowledge may be created through shared coding schemes in small groups, so attempts to shift it may be met with problems, because of a failure to understand different coding schemes (Dougherty, 1992).

Table 2: Summary of key characteristics of the configurations

Configu- ration	Combination of the knowledge dimensions	Key characteristics of the configurations
A	Explicit/ Collective/ Architectural	Knowledge intensive firms which operate a 'codification' strategy. Emphasis is on codification by creating knowledge objects for use and reuse by those within the organisation.
B	Explicit/ Collective/ Component	Reliance on a core group of 'knowledge workers' such as those with a particular technical specialisation or in an RandD dept. Employees know which collectives to access specific knowledge from. In this case the knowledge is highly codified through strict procedures and record keeping.
C	Explicit/ Individual/ Architectural	Individuals have a strong and clear understanding of knowledge, compensation and structural isolation may be needed to stop these key employees becoming competitors. The knowledge is able to be clearly structured via written or verbal communication.
D	Explicit/ Individual/ Component	A concentrated group of definable 'experts' whose expertise is modifiable, such as knowledge about particular markets, product attributes, or a part of a process. Often the knowledge will not be understood by other employees.
E	Tacit/ Collective/ Component	Groups of specialised knowledge workers operate as a collective base for knowledge. The key drivers of knowledge transfer would be problem solving and social recognition.

F	Tacit/ Collective/ Architectural	Similar to E, but in this context the group represents the majority of the organisation. Based around a culture of shared understandings.
G	Tacit /Individual/ Component	A number of key experts who have 'know-how' and are able to apply their specialised knowledge to deliver value for the organisation.
H	Tacit/ Individual/ Architectural	Know-how is distributed across the entire organisation. This is most likely to be found in a small highly specialised firm.