Original Paper

K-Form Organizations

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Abstract

Contemporary organizations are confronted with increasing challenges in matching their structural designs to the ever increasing flood of information and to the necessity to translate this information into actionable knowledge represented in innovations. The progression of organizations from U-forms, or simple unitary functions represented in classic bureaucracies, to M-forms, or multidivisional structures with many products often manufactured in many places were both embedded in a one-to-many framework, a top-down approach. However, modern organizations need to develop deeper and deeper tacit understandings that can lead to actionable knowledge that results in innovations and unique strategic advantages. This suggests a need to describe a newly emerging organizational from – the K-form. After detailing its fundamental unit, knowledge spheres, representing the increasing understanding from recognition of patterns in matter and energy to information to explicit and tacit knowledge to wisdom, how these spheres interact within a knowledge cube, formed by three dimensions of domain, access, and function is discussed. Finally, the implications for practice of this approach, the integration problem, and the importance of visualization are examined.

Keywords

organizational design, organizational structure, knowledge, innovation, integrative mechanisms

1. K-Form Organizations

Contemporary organizations are confronted with increasing challenges in matching their structural designs to the ever increasing flood of information and to the necessity to translate this information into actionable knowledge represented in innovations. Chandler's (1962) seminal work detailed how the emergence of new structures that match emerging strategies can often be torturous, with many fits and starts, with various degrees of mindfulness on the part of management. He also described a basic set of issues, which are even more pronounced today, concerning the information processing limits of upper management, their need to synthesize in some way the information available to them, and to then develop actionable strategies that better control and focus their organization's operations. These issues, which are central to modern management, will be explored in depth in this review.

Chandler was detailing the progression of organizations from U-forms, or unitary functions represented in classic bureaucracies, the simplest form of structure focusing on one product line in one place, to M-forms, or multidivisional structures with many products often manufactured in many places. Since then various other forms have been described, with most organizations still in a one-to-many framework, a top-down approach.

However, an emerging focus on knowledge suggests a many-to-many approach, often representing extreme solutions to coordination and collaboration problems, with an implicit questioning of the old saw that hierarchy is inevitable(Johnson, 2009). Increasingly new organizational forms will be driven by knowledge, expertise (specialization) concerns. Thus, we have new forms of collectives, cooperation that almost appear leaderless (e.g., smart mobs), an emphasis on the wisdom of crowds in social networking software, Wikipedia, open-source software, and so on(Johnson, 2009). Organizations need to develop deeper and deeper tacit understandings that can lead to actionable knowledge that results in innovations and unique strategic advantages in a resource-based view (RBV). However, the exploration of ever deeper tacit understandings also implies that an organization has only limited abilities to pre-plan and to design elaborate formal structures.

The increasing demand for knowledge and resulting innovation suggests then a need to describe a newly emerging from – the K-form – that will be the focus of this article. First, I will describe the fundamental unit, knowledge spheres of this design, then I will discuss how these spheres interact within a knowledge cube. I will conclude by discussing the implications for practice of this approach, the integration problem, and the importance of visualization.

2. Knowledge Sphere

Figure 1 pictures a knowledge sphere, representing the deepening understanding of our surrounding world from first a recognition of patterns in matter and energy to information to explicit and tacit knowledge, to ultimately wisdom, that is a useful starting pointing for portraying the basic components/building blocks of a K-form organization. Individuals and groups develop differing levels of understanding of various organizational domains, with more surface levels more readily observable and shared as explicit knowledge. Spheres emerge from the field of matter and energy within which the organization is embedded resulting in a progression from information to knowledge to wisdom representing by progressively intense hues. While there is a generally recognized ordering among these terms, with wisdom having the least domain coverage of the other sets, they are often used interchangeably and in conflicting ways in the literature, resulting in some confusion(Johnson, 2009). The increasingly limited set associated with higher order terms also can be associated with greater personal interpretation (and hence potentially more idiosyncratic meanings)(Boahene & Ditsa, 2003), representing a progression of states (Holsapple, 2003).

It is important to distinguish between types of knowledge, since they can have different impacts on

processes like knowledge transfer (Reagans & McEvily, 2003) and the inherent possibility that differing groups can collaborate to common ends. There have been a plethora of approaches to classifying types of knowledge (Johnson, 2009). Fundamentally two types of knowledge, tacit and explicit, are critical for design decisions (Nonaka, 1991). The distinction between these two types of knowledge is derived from the work of Polanyi (1974)who was concerned with developing a general philosophical system for describing personal knowledge in both the arts and sciences, applying it to a broad range of societal problems.
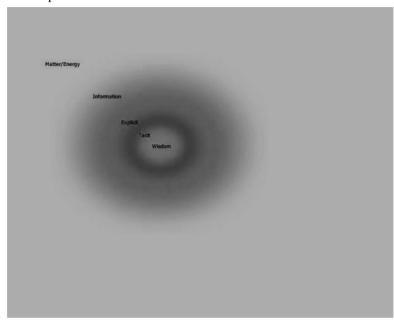

Figure 1. Knowledge sphere cross-section

Explicit knowledge is easily transferred because it can be encoded in a widely recognized symbol system and traditionally it was the backbone of formal structural approaches. In the network literature this has also been referred to as migratory knowledge since it refers to information in books, designs, blueprints, and so on that can be easily moved from one location to another (Monge & Contractor, 2003). In economics similar notions underlie the concept of general knowledge which is relatively inexpensive to transfer (Jensen & Meckling, 1995).

Knowledge codification represents the translation of explicit knowledge into some written or visual format (Ford et al., 2003). It can increase the quality and speed of knowledge creation and distribution (Kayworth & Leidner, 2003). Fundamentally, for explicit knowledge to be transferred, there must be a shared symbol system with common meanings for the same symbols among network members. This codification can take many forms - blueprints, documents, diagrams and so on (Ford et al., 2003). This form of knowledge is fundamental to U-Form organizations.

Tacit knowledge presents special challenges and can only be transferred under exceptional conditions. Tacit knowledge derives its value from being inimitable, it is hard to leverage because it is difficult to codify: however, codifying it makes it imitable producing a basic paradox that organizations must

balance (Coff, Coff, & Eastvold, 2006). This has also been referred to as embedded knowledge that is associated with craftsmanship and unique talents and skills that are particularly difficult to transfer across organizational or group boundaries (Monge & Contractor, 2003) or, in economics, specific knowledge (Jensen & Meckling, 1995). This type of knowledge has been described as 'sticky' because it is difficult to spread due to such issues as causal ambiguity, absorptive capacity, retentive capacity, and the arduousness (e.g., maintenance over a distance) of the relationship (Szulanski, 1996).

Leonard and Sensiper (1998) have further elaborated the concept of tacit knowledge by identifying three different types of it in the contexts of developing innovation in organizations. A guiding concept resides at a high level of abstraction and is often metaphorical. It also may have totemic, visual quality that is often found in the realm of product design that captures the 'style' of a particular company, such as Apple. Collective tacit knowledge arises from interaction in the same group and resides in the head of each socialized group member. Overlapping specific tacit knowledge arises from groups working on common, interdependent tasks. Another special form of tacit knowledge, embedded knowledge, resides in systematic routines (Blackler, 1995), such as the rites and ritual of corporate life. All of these distinctions emphasize the social nature of knowledge which at their root implies sharing experience at an increasingly fundamental, yet particular, level, reflected in the spheres that develop at the intersection of forces represented by the dimensions of the knowledge cube.

Nonaka (1991) developed a more dynamic, interactive approach to these issues focusing on the implications of the spiral of knowledge and its articulation (converting tacit to explicit) and internalization (using explicit to extend one's own tacit knowledge). Thus professionals may gather large amounts of information to develop insights into deeper problems (e.g., financial trends) then articulate them, as financial brokers do, to specific buy and sell recommendations for their clients.

Because of the immense effort needed to establish tacit knowledge, spheres develop their own gravitational force. So they can attract others whose tacit knowledge can add to the mass of these bodies, similarly to the aggregation of new planets, which takes time to develop, just as tacit knowledge associated with crafts does (Sennett, 2008), but they also can create difficulties in escape velocity (e.g., stickiness), at times creating black holes which allows nothing to escape. Of course, for organizations, having individual spheres of tacit knowledge does very little good, and may indeed do harm, if knowledge only builds within them and is not shared with others, becoming energy/mass sinks from which nothing escapes.

3. Concert of the Spheres: Designing the K-Form

The question for managers, then, is what forces they can use to shape the development of these spheres. Figure 2 describing three dimensions of an organization's knowledge space in which spheres form from combinations of domain/product, access/proximity, and functional/professional/specialization forces with the most interesting combinations where all three of these things combine to form denser, more

quickly developing spheres. So, in the upper left quadrant of the figure we find a sphere that is limited in domain and functional coverage separated from other units in the organization such as one might find in janitorial services or night time security operations. On the other hand, we find in the center, a much larger sphere that encompasses a smaller one that might reflect a particular specialization (e.g., patent law) at a central location within a larger grouping of professionals (e.g., corporate lawyers) in a law firm. This might reflect the sort of hybrid structure often represented in matrix organizations coupled with a management decision to collocate them.

The knowledge sphere is a major departure from the classic design approaches represented by Galbraith (1973) and echoed in the work of Lawrence and Lorsch (1967), with some arguing that K-form organizations should not at their core, at their root, be based on bureaucratic principles, that they require fundamentally different approaches, with bureaucracy operating in parallel, or shadowing, a focus on knowledge generation and implementation, much like in universities where knowledge workers are not fundamentally governed by bureaucratic procedures in their pursuit of knowledge, but in which bureaucratic procedures provide a medium of explicit knowledge, reflected in the background shading in Figure 2, for things like purchasing supplies.
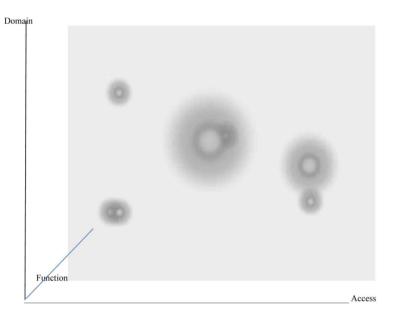

Figure 2. Knowledge spheres in cube

Developing a winning strategy through design combines both art and science and may be the ultimate act of managerial creativity (Roberts, 2004). So, designers can be considered master builders who lay the foundation for all that follows in the organization. Recently it has been argued that management theorists need to revisit design, which has been relatively neglected in spite of its critical role in organizational performance, but the very complexity of the issues confronting modern organizations, especially those surrounding knowledge, discourages them from doing so (Palmer & Dunford, 1996). The symptoms of poor design are legion, including: lack of coordination, excessive conflict, unclear

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roles, misused resources, poor work flow, reduced responsiveness, proliferation of ad hoc entities (e.g., task forces, committees) and virtual positions (Mackenzie, 1986), "grey areas" in which responsibilities of different entities are unclear, and so on (Nadler & Tushman, 1997). All of these factors may be present in K-forms because of their inherent messiness, it is the role of management to try to ameliorate them in pursuit of developing signature competencies for the organization.

Classically designers have contrasted functional, U-form, and product, M-form, approaches to design along several critical dimensions. Table 1, derived from a comprehensive literature review of this area (Johnson, 2009), compares these designs with K-forms along the following dimensions: knowledge creation, proximity, specialization, problem solving approach, certainty of personal, formal control, adaptability to environment, resource-based view, efficiency, and effectiveness. Functional approaches are what is commonly thought of first when considering a formal organizational design and their primary objective is to maximize efficiency through specialization and formal authority and they are best used when stable performance on routine tasks is required (Walker & Lorsch, 1968). The functional approach has many advantages since it is: the starting point for most organizations; highly efficient; permits standardization; maximizes investments (e.g., capital equipment); and beneficial for people with low tolerance for ambiguity. It provides a stable and secure work setting (Dess, Rasheed, McLaughlin, & Priem, 1995) and works best in organizations of small size, with long product development cycles. It also has many disadvantages: bottlenecks, decisions pile up at top; segmented concern; product variety is problematic since specialization assumes one size fits all; barriers to cross-functional, lateral relations (e.g., silos); slow to respond to environment; and lacks customer, stakeholder orientation. Unfortunately, there is often not a clear overlap between formal organizational charts, which focus on hierarchical status and power relationships and the actual flow of work represented by interdependence concerns and the interlocking roles that determined the flow of knowledge in organizations. Another difficulty with U-form organizations is innovation/experimentation tends to be system-wide, whereas in M-forms you have divisions that can experiment with different practices (Qian, Roland, & Xu, 2003).

Table 1. Comparing designs

Dimension	U-Form	M-Form	K-Form
Knowledge Creation	Narrow Focus	Domain specific	Maximized
Proximity	High	Multi-Factorial	Convergence of Forces
Specialization	Limited	Dual	Within spheres
Certainty of Personnel	Highest	Bifurcated	Uncertainty maximizers
Formal Control	Highest	High	Lowest
Adaptability to Environment	Low	Moderate	Highest
Resource-Based View	Primitive	Lodged in Domains	Signature
Efficiency	Highest	High	Lowest
Effectiveness	Lowest	Moderate	Highest

Functional designs have been increasingly supplanted by domain-based designs that focus on a particular type of tacit knowledge critical to the organization. Product-driven design is probably the most popular of the domain design types. There are many other domain-based designs, with geography (e.g., plant/facility, country), markets, and process/technology also being popular, with interdependence based internal transfer of information and external relations dependent on the domain, be it a regional, product or process focus.

The primary objective of domain approaches is to emphasize different organizational products or services, recognizing that functional specialization needs might change across them (e.g., different design teams are needed for sports cars vs. trucks, different human resource functions are necessary for knowledge workers vs. unionized industrial workers) (Walker & Lorsch, 1968). Recruitment is complicated by some blending of functional specialization and domain (e.g., entertainment lawyer), but sometimes this can aid retention because a dual specialization may limit mobility.

The M-form approach is usually next on the evolutionary stage of an organization's growth and it is adopted for its advantages: focus on products; shorter development cycles; more responsive to customers; more responsive to environmental changes; enhances coordination, lateral relations, across functional specializations within products; and develops higher level of tacit knowledge within domains. However, it also has key disadvantages: reinventing the wheel, duplication across each product line; non-standard approaches to common problems; knowledge developed in specialties (e.g., personnel) within products difficult to spread, sticky; missed opportunities for knowledge sharing; lost economies of scale, common investments in capital; and customers, other outsiders often do not know who to contact with their concerns. The classic M-form organizations (e.g., Sears, GM) once trumpeted for their success (Chandler, 1962; Fligstein, 1985) have more recently been the poster boys for organizational problems (Bartlett & Ghosal, 1993).

The critical question that designers must face is what theme will be emphasized, what value will be stressed in their design, just as architects must balance function with aesthetics. Traditionally designs have faced tradeoffs relating to a variety of concerns, with strategy often implicit in the choices that are emphasized (Nadler & Tushman, 1997). The primary factor that makes design more of an art than a science is the resolution of many conflicting concerns, with Keidel (1984), for example, emphasizing the need to balance control, cooperation, and autonomy. Alternatively, March (1994) has emphasized the critical choice between exploration and exploitation of knowledge that relates to the most important dilemma of balancing specialization and coordination (Qian et al., 2003). The central problem, then, is to try to maximize complementarities (Roberts, 2004); to achieve synergies rather than energy draining conflict and artificial supremacy of one concern.

In the attempt to balance opposing organizational design imperatives knowledge has not often been taken into account historically, beyond the specialization associated with formally assigned roles and the development of idiosyncratic domain knowledge. Although tangentially there has been recognition

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that one central design element is who will absorb uncertainty/complexity and by implication be forced to learn new things and approaches (Galbraith, 1995). It is time for a more positive approach to this problem, focusing on how different designs deepen our tacit understanding of key organizational domains.

In general, the failures of traditional design approaches to deal with our rapidly changing world, has led to a number of approaches to reducing both internal and external boundaries through modular, virtual, and barrier free types of design (Dess et al., 1995) that often focus on projects(Boh, 2006). Customer-based approaches may serve as precursor to more explicitly knowledge-based approaches and considerably dampen the functional specialization legacy in the interest of making customer service supreme. Organizational members in essence serve as customer liaisons who do the navigation of the organization for the customer, serving as their broker in effect. The unique tacit knowledge they develop is of the customer. Knowledge creation, innovation implementation, problem solving are all oriented to the needs of individual customers. Individuals recruited for these positions must be highly adaptable and responsive to customer needs, ready to serve them in an instant. Effectiveness becomes totally dependent on the relationship between customer and their liaison, as a result the organization becomes considerably less efficient because of the lack of internal knowledge transfer, generalized learning, and the need for slack resources to respond to specialized requests. Hospitals are experimenting with this sort of coordination of care network to better serve patients (Gittell & Weiss, 2004).

Often the effects of design have been latent rather than manifest, that is design decisions would often achieve certain effects because of their underlying impacts (Gittell & Weiss, 2004). So, strict principles of super-subordination found in bureaucracies imply that organizational intelligence is best lodged at the apex of organizations, where decisions are made based on the synthesis of a variety of sources of information. Little credence is given in this framework to tacit knowledge of those close to the information, rather the focus is in the development of tacit understanding of key administrators. Some might even go so far as to argue that any attempt to govern the messy world of knowledge with rigid designs is ultimately paradoxical.

3.1 K-Form Designs

Knowledge based designs need a different graphical approach that can capture the complexities we described in the knowledge sphere. Prior attempts to visualize primarily internal markets, have been hopelessly complex (e.g., Galbraith, 2010; Marchand & Horton, 1986). Knowledge based, or K-form designs focus on free-flowing communication; with minimal layers in a hierarchy; a mixture of generalists and specialists approaches (Postrel, 2002); the importance of brokers; decentralization in the sense that knowledge that is crystallized can be immediately be applied to problems by those who discover it, and with free flowing links outside. All of this is similar to market-based approaches.

The fundamental goal of this sort of design is to analyze, create, or transfer knowledge to solve

problems. The primary strengths of knowledge-based designs (see Table 1) include: adaptability; maximizes innovation; maximizes creative problems solving; heightens growth and organizational learning; retention of people who have a high preference for uncertainty, need for cognition; high adaptability to turbulent environments; focus on employee development (Keidel, 1984); entrepreneurial freedom; highest effectiveness in terms of fit to environment; and CoP development (Wenger, McDermott, & Snyder, 2002). The primary weakness of knowledge-based designs are: uncertainty, frustrating to traditional employees (Keidel, 1984); high possibility of disorder; very risky; hard to explain to others; institutionalism perspectives; who is in charge?; low security; may not deal with equity issues well; low preservation of public goods; free riders; lower efficiency in terms of standardization and capital equipment; inhibits common vision, integration of organizational efforts; intellectual property, ownership issues; high level of trust needed to facilitate relationships (Dess et al., 1995); and how does an organization goes about forgetting (Govindarajan & Trimble, 2005).

Since KN are so fluid, drawing simple boxes and lines, as in a traditional organizational chart, suggests an inappropriate permanence and an illusion of control that also fails to capture the layering of knowledge. Knowledge is something that is inherently social (Brown & Duguid, 1998; McDermott, 1999; Orlikowski, 2002), bound to particular contexts (McDermott, 1999; Swan, 2003; Tsoukas & Valdimirou, 2001), and something that can be communicated to others, even if it may take considerable effort and require the development of mutually agreed upon symbols. Reflecting the work of American pragmatist philosophers such as Dewey and James, there has been a move away from objective views of knowledge to one that is fundamentally indeterminate and anchored in an individual's day-to-day interactions (Hjorland, 2007; Nag, Corley, & Gioia, 2007) which in turn are often shaped by organizational designs.

3.2 Other Approaches to K-forms

Several new types of structures, modular, hypertext, and so on have been suggested to promote the types of collaborative relationships and knowledge generation increasingly needed in contemporary organizations (Gold, Malhotra, & Segars, 2001) and are also evocative of what is needed in K-forms. One type of experiment is cellular organizations build on principles of entrepreneurship, self-organization, and member ownership (Miles, Snow, Mathews, Miles, & Coleman, 1997). The cell metaphor, with overlapping elements like Figure 1, implies both a functional orientation and internal structure, coupled with a need to interact with other cells to perform larger functions. Another approach involves viewing the firm as a distributed knowledge system where individuals manage the tensions between normative expectations, personal dispositions, and the local context when they can only know a portion of what is known throughout the organization (Tsoukas, 1996). This combination of interdependence and independence allows teams to develop and share know-how that promotes overall adaptability and innovation.

Another type of early metaphoric approach is associated with holographic organizations derived from

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brain functioning (Morgan, 1986). Holography captures how processes develop where the whole can be encoded on all of its parts. For example, memory is distributed throughout the brain and can be reconstituted from its parts. This is done in part by rich connectivity between parts that can be reorganized as the organism learns to adapt to new demands.

"Spaghetti" organizations representing knowledge centers linked by a multitude of non-hierarchical links have also been suggested as a way of maintaining knowledge-based competitive advantage, but case studies indicate that one major difficulty that these new forms encounter is the very human tendencies of managers to attempt to regain some control of events, a more comfortable level of certainty about what is occurring(Foss, 2003). Unfortunately these approaches do not focus on the forces embedded in organizations that lead to the development of knowledge spheres within the space represented by the knowledge cube.

4. Knowledge Cube

In complex social systems everyone's context is somewhat unique, giving the appearance of individual differences attributable to individual locus variables (Richards, 1993). The concept of field has a long tradition in the social sciences tracing back to the seminal work of Lewin (Scott, 2000) with interesting recent variants such as the information horizons (Sonnenwald, Wildemuth, & Harmon, 2001), information grounds (Fisher, Durrance, & Hinton, 2004), and small worlds (Huotari & Chatman, 2001). These common contexts are important for transferring knowledge in our increasingly virtual organizations. In sum, then, individuals are embedded in an 'heuristic field' that promotes their tacit knowledge (Polanyi, 1974).

An individual's information field is a familiar concept that relates directly to the notion of spheres. It contains resources, constraints, and carriers of information (Archea, 1977; Di Maggio, 1986; Hagarstrand, 1953; Rice, McCreadie, & Chang, 2001). People are embedded in information fields that determine their level of awareness and depth of knowledge of particular issues. While context is an integral part of the definition of knowledge, and is often fundamental to the development of tacit knowledge, the extent to which it can be systematically related to other issues is limited by the dearth of literature related to it at any meaningful level (Johnson, 2003), which leads to a focus on the knowledge cube.

There are many potential design dimensions, which determine the scope of the firm, that need to be balanced in particular approaches to K-form (Roberts, 2004), each with different implications for the development of tacit knowledge and its dispersion throughout the organization. Here I will emphasize three dimensions, knowledge domain, member function, and access, that form the knowledge cube (see Figure 2), reflecting the internal forces leading to tacit knowledge growth within spheres. Management can draw on these forces to purposively shape organizations, but not in the precise diagrams represented in the classic organizational chart.

Rather than lines and boxes the new organizational designer has to be aware of forces and fields and the gravitational arcs between them. The knowledge cube contains a three dimensional space defined by knowledge domain (representing particular products and/or services), member function (job, professional specialties), and access (most often conceived as spatial/geographical). Naturally there are smaller, localized spheres of tacit knowledge at the intersection of these forces. So, in a law firm a partner might specialize in entertainment (knowledge domain) law (profession) within the same geographically bounded office.

Traditionally member functions highlighted what overall business a firm was in and what specializations were needed to accomplish its strategy. Specialization of function was revealed in differentiation of the organization's formally assigned roles, further reinforced by professionalization, also related to the distribution of knowledge, with jobs and associated skill sets overlapping substantially with tacit knowledge. Formal approaches excel at the development of pools of knowledge, but they minimize the circulation of knowledge among them. These issues also relate clearly to the dilemma of how we leave it to the "man (sic) on the spot" to translate their tacit knowledge to act in particular circumstance in a timely manner, while preserving the larger interests and goals of the organization (von Hayek, 1945), the integration problem.

More recently, especially for conglomerates and very diverse organizations, product driven designs, which may require different specialization mixes, have been used (Galbraith, 1995). Products represent knowledge domains that contain not only knowledge of product per se, and the materials and processes needed to produce it, but also knowledge of environmental factors, which often demand speedy responses and organizational adaptation, such as customers and competitors. These designs, and the need for mutual adjustment, produce heightened pressures on integrative process in organizations and on customer interfaces that buffer the complexity of the organization for them.

Accessibility, especially in terms of physical propinquity, is also important (Borgatti & Cross, 2003; Cross, Rice, & Parker, 2001; Hirsch & Dinkelacker, 2004). One of the classic observations about communication is that it is more likely to occur when individuals are within a rather limited physical distance (Allen, 1977; Johnson, 1993). Access may also be the single most important criterion in evaluation by users of an information system (Jansen & Rieh, 2010; Rice & Shook, 1990). It can also be promoted by a lack of status barriers associated with rules that block the flow of information. Access can be enhanced by various mediated technologies that, in effect, create electronic propinquity in Korzenney's (1978) terms. Even in today's internet world, with an increasing array of means for overcoming distance in collaborative work, distance still matters (Olson & Olson, 2000). Beyond physical propinquity, access promoted by formal relational bonds also enhances knowledge transfer (Owen-Smith & Powell, 2004).

There is an extensive pragmatic literature on open office landscaping, and a variety of computer programs designed to facilitate physical layouts of plants and offices, often explicitly based on

communication between units. Naturally these techniques are heavily rational and share many of the strengths and weaknesses of formal design approaches in general. Perhaps the most telling point in this connection is that when people first move into buildings they often complain about how formal things have become and how difficult it is to communicate (Canter, 1983). Thus the formal networks associated with physical location need to be 'fleshed out' by the actors to satisfy their individual needs. In this connection Canter (1983) has argued that, while having a minimal effect on formal networks, spatial factors can be expected to have a more pronounced effect on informal networks.

While both social density and proximity act to determine the access of individuals to each other, access is also affected by the relative mobility of individuals. Increasing mobility can be a direct result of technologies, but the necessity for this mobility can stem from utilitarian imperatives associated with problem solving as well. Information seeking imperatives often demand that individuals transcend their local physical environment to seek out others on whom they depend for information. At this point utilitarian concerns result in individual's seeking alternative pathways or channels for reaching distant others (Johnson, 2009).

In summary, knowledge spheres develop at the intersection of three primary forces, access, domain, and function, within a knowledge cube. As Figure 2 demonstrates, at times this results in highly intense spheres that are relatively isolated within the organization (upper left sphere). At other times spheres develop within spheres as in the ever increasing number of medical specialties within hospitals represented in the middle of the figure. Spheres also brush against each other, as in the far right representation, sometimes abrasively, sharing some explicit knowledge, such as both marketing and accounting relying on the same sales figures, but never truly developing tacit understandings and often interpreting them in substantially different ways. Finally, as in true teams and the ideal of Communities of Practice sometimes spheres intersect, as in the bottom right of the figure, to such a degree that they truly come to share some tacit knowledge with each other. In toto, these different levels of knowledge intensity at the intersection of the three primary forces represent a unique knowledge signature for a firm.

5. Discussion

In this essay I first described the fundamental unit of K-form designs, knowledge spheres, then I discussed how these spheres interact within a knowledge cube. I will conclude this article be focusing on the implications for practice of this approach, the problem of integration, and the importance of visualization.

5.1 Implications for Practice

Given the distributed character of organizational knowledge, the key to achieving coordinated action does not so much depend on those 'higher up' collecting more and more knowledge, as on those "lower down" finding more and more ways of getting connected and interrelating the knowledge each one has

(Tsoukas, 1996, p. 22).

Management's most important role in these perspectives is in providing a stimulus or cue to action. They must define the most important issues that an organization needs to face, setting the agenda, which usually entails specifying what are the key domains an organization must develop. Rogers (1995) has identified agenda setting as a central role of management in the diffusion of innovations. In this view, management identifies and prioritizes a need, as well as encourages information scanning in an organization's environment for potential solutions. A letter from the President in a company newsletter may identify a top organizational priority (e.g., developing new products to meet increased competition). Successfully establishing this agenda will shape the forces that develop spheres. Thus, a critical role of management in the innovation process is that of managing attention(Van de Ven, 1986). The knowledge cube draws attention to three things that managers can manipulate to enhance the likelihood of the development of knowledge spheres - access, domains, and individual functional specializations. By doing this managers also develop a strategic focus for their firms.

Perhaps the key thing a manager can provide is the time for tacit knowledge to develop. It is generally assumed that some form of the 10,000 hour rule is in effect, to truly develop a deep understanding of a craft, a person must be willing to devote the time and resources necessary (Sennett, 2008). But there is also a paradox here the more time they devote the less the likelihood that the resulting sticky knowledge can escape from the gravity of their sphere and be transferred to others.

Ultimately rational decision choices require careful thinking about what is really valued in the organization. At times formal structures can offset other weaknesses such as geographic dispersion and the loss of closeness desired relationships because of the growth of organizations. The fundamental/bottom-line issue is what competitive advantages does management really want to develop.

Organizations might expect all of this three dimensional space to be covered, but in an resource-based view it is their idiosyncratic pattern of tacit knowledge development that forms a unique signature for a firm and the gaps in coverage that represent opportunities for brokers to confront integration problems. So, one firm places its bets in one portion of the space, while another develops a different portion. Sometimes this develops from the attraction of actors in the space and their unique knowledge and accidents of proximity, but it can also be nudged by promoting access to functional specialties which may form Communities of Practice.

5.2 The Integration Problem

Tying together people in new ways is hard work – it is at the frontier of our understanding of management practice, social networks, and technical augmentations. One should not expect simple solutions (Ackerman, Pipek, & Wulf, 2003, pp. xv).

Ever since is earliest beginnings design approaches have been confronted with the fundamental issue of how an organization integrates the efforts of its diverse units in the pursuit of common goals. Since this

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need for integration is often in response to unique environmental circumstances, it is difficult to draw permanent maps, as in organizational charts, that anticipate all of the types of integration that may be necessary.

The contemporary interest in network analysis in part stems from its adaptability to this problem (Johnson, 2004) and the perceived lack of brokers and intermediaries to turn to for knowledge sharing (Matson, Patiath, & Shavers, 2003). So, exposure to weak ties may provide information that suggests the possibility of a change that needs to be explored and this may trigger an expansion of the individual's information field**.** There also is the classic finding that people are attracted to liaisons because of the knowledge they have and in this way integration is accomplished not by those who are the most central, but through the initiative of those at the periphery (Reynolds & Johnson, 1982).

Indeed, individual initiative has become central to modern network explanations of integration. So brokers have a feel for gaps, and are drawn to the spheres and the structural holes (Burt, 1992) between them in the knowledge cube. They seek the advantages that can accrue to those individuals, in Likert's (1967) classic description, who can provide the linking pins that hold organizations together. Unfilled gaps in shared knowledge can lead to significant excess costs for companies (Hoopes & Postrel, 1999).

5.3 Importance of Visualization

The highest art, both in itself and in graphical display, is finding the unexpected. Done properly pictures...offer us the greatest hope of doing just this (Tukey, 1980, p. 492).

While relationships for network analysts typically are cast in terms of linkage and for designers lines of control relationships in hierarchical relationships, for K-form relationships might be better thought of in terms of relative intensities of communication which occur in a knowledge space. One of the essential factors associated with the growth of any discipline is the availability of a number of techniques by which it can conceptualize and/or analyze the phenomenon of interest. Spheres and knowledge cubes represent a potential methodology for investigating K-forms. In general, it has been argued that some of the most useful discoveries in the history of science have been associated with visual imagery and visual representations (Klovdahl, 1981). Today's advances in computer graphics and visualization offer us a host of opportunities for the development of new tools for examining K-forms. These visual representations have the potential for becoming metaphors of powerful heuristic value. They may describe more concretely complex relationships in a manner which makes them more comprehensible and which can stimulate analytical thinking and investigation (Schmid & Schmid, 1979).

6. Conclusion

Every approach to design has specific strengths and weaknesses. Managers need to be aware of these and be prepared to constantly monitor their potential weaknesses so that they can be ameliorated through their actions. They also must realize that there is a basic shift in their responsibilities as design becomes more complicated, since it provides the context within which organizational processes and

routines occur that constitute one form of tacit knowledge (Choo, 2006; Tsoukas, 1996), and they are no longer the ones who are the ultimate focus of these processes (e.g., decision making) (Galbraith, 1995). It is important that the ultimate goals of a particular design be kept in mind, especially since they provide the markers against which success can be measured and are a key element of an organization's strategy (Roberts, 2004). In our emerging world this may be better thought of in terms of forces, fields, and spaces, rather than the more confining lines and boxes.

Footnotes

[1] For example, N-form for new, novelty (Hedlund, 1994) which focuses on the combination of tacit knowledge (rather than its separation as in M-form), temporary constellations of people, bottom-up processes, lateral communication, and a catalytic, architectural role for top management or the KNETS which emphasize knowledge networks (Palmer & Richards, 1999).

[2] There have been some prior passing references to K-form (Barnett, 1997; Puga & Trefler, 2003), but they had neither the focus on knowledge nor the full length examination developed here. There also have been other metaphors, such as spillover knowledge pool, that evoke some of the same meanings as the knowledge sphere (Adler, 1995) or lumps of butter forming in buttermilk(Micklethwait & Wooldridge, 2005).

[3] Much more globally, information is sometimes equated with any stimuli we register or recognize in our environment(Miller, 1969). In this view information involves the recognition of patterns in the basic matter/energy flows around us (Bates, 2006; Case, 2007; Farace, Monge, & Russell, 1977; Hjorland, 2007). Information can also be viewed as the number (and perhaps kind) of messages needed to overcome uncertainty(Krippendorf, 1986). In this view, information is of value if it aids in overcoming uncertainty; traditionally a fundamental driver of design (Galbraith, 1973).

Knowledge implies a deeper level of understanding and apprehension than that represented by data or information, although, similarly to information, it has often been defined in a variety of ways that are at times elusive (Birkinshaw, Nobel, & Ridderstrale, 2002; Smith, Collins, & Clark, 2005). Webster's fourth edition (1995) lists two elements that are critical to our understanding of the concept: 1. to have a clear perception or understanding of and 5. to have understanding or skill as a result of experience. Naively then knowledge sometimes approaches the meaning of truth(Boulding, 1966) and becomes the basis for action (Satyadas, Harigopal, & Cassaigne, 2001). Knowledge is often the residue of thinking, reflecting upon experience. This is critical for organizations, since knowledge becomes something you can do something with. As a result it often leads to strategic advantages since organizations who have the best understanding of their environment and then act on them accrue competitive advantages. wisdom represents the special case of actionable knowledge that: "implies superior judgment and understanding based on broad knowledge" 1. … the power of judging rightly and following the soundest course of action, based on knowledge ….5. a wise plan or course of action (1995).

[4] This is associated with the 10,000 hour rule for truly learning, mastering a craft (Sennett, 2008) and developing the understanding to provide a unique contribution. The greater one's understanding, the more one is set apart from others.

[5] The somewhat related notion of spheres of influence has been widely applied in settings ranging from foreign relations to community power theory (Baldridge, 1971).

[6] Individual action and choices may be context driven, but the diversity of contexts makes this difficult to uncover. Individuals may also choose contexts that best match their characteristics, which further clouds the impact of context (Kindermann & Valsiner, 1995b).

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