Towards a valuation of knowledge in systems using qualitative system methods.

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Abstract:

Knowledge in a firm is a highly desirable intangible resource imbuing competitive advantage due to its inimitability, but often that linkage between knowledge and competitive advantage is not explicit. Moreover, it is often not explicitly valued by an organisation so that exhortations to train, develop, disseminate and publish are often met with resistance since no valuation on the knowledge (and particularly tacit knowledge) in a firm is easily available. After a discussion of the types of knowledge immanent in a firm (knowing what, knowing how, knowing why and knowing who), we present a method of modelling the knowledge in an organisation and of relating that knowledge specifically to its business survival. This method of modelling allows the representation of knowledge types and the mechanisms of their contribution to the generation of value. Using the real-life case of a professional firm we show how the system of that firm can be modelled and used to establish the knowledge usage and requirements of the people in that system in support of their intent for action.

Towards a valuation of knowledge in systems using qualitative system methods.

The importance of valuation

The importance of knowledge in creating competitive advantage is well understood (Drucker, 1993;, Lubit, 2001; Scarborough & Swan, 2001; Shadur & Snell, 2002; Strock & Hill, 2000). The very ubiquity of this acceptance, however, tends to hinder the efficiency of application of resources in managing that knowledge. Two specific causes of inefficiency are: a lack of understanding of what knowledge *is* and an inability to identify what contribution *valuable knowledge* makes to the organisation. For instance, many organisations have sophisticated knowledge management systems but the activities of these systems are not directed in a discretionary way towards that knowledge which is most valuable to the business. This leads to waste of knowledge management resource and to the 'management of knowledge for knowledge's sake' without regard to its contribution to the sustainable competitive advantage of the firm.

It is inherently difficult to evaluate knowledge in a system. These difficulties exist at two levels. Firstly, in respect of tacit knowledge, it may not be evident even where the knowledge lies. Secondly, in respect of explicit knowledge, while the knowledge is more visible, its rôle in the value generating systems of the organisation may not be appreciated.

In the section that follows we describe these forms of knowledge in more detail.

The 'problem' of knowledge

Knowledge is regarded as a slippery concept (Leonard & Strauss, 1998) that is difficult to pin down and manage. As a result many attempts have been made to categorise, codify and demystify knowledge in order to enable its management. During the late 90s there was a tendency to ignore the dynamic nature of knowledge so as to move towards a position where we can create and apply this valuable resource (Drucker 1993). The focus then was more on the use and measurement of knowledge rather than understanding its nature. The approach we take in this paper, however, is

that we need to understand the nature of knowledge, and indeed its value to the organisation, before we invest in its management.

Knowledge, information and data

At the outset it is important to be clear about the differences between knowledge, information and data. Spender ((Spender 1996), p. 65) postulates two radically different kinds of organisational knowledge, i.e., data and meaning, each generated, stored and applied in completely different ways, while intelligence shapes, and is shaped by, their interaction. Data can be regarded as the cellular level of an information system that may or may not contribute to a wider understanding (Allee 1997), p. 115) or in organisational terms as structured records of transactions (Davenport and Prusak 1998), p. 2) an example being a spreadsheet with numerical input.

Information can be seen as data that has been contextualised and categorised. For example, I may obtain information about a holiday in the Caribbean in a travel agent's brochure. This is data that has been contextualised (my holiday being the context). However, if I have not been on a holiday in the Caribbean and have no experience of the heat, the culture the beaches, then I cannot say that I have knowledge of a holiday in the Caribbean, I merely have information about what the experience may be like. This is wholly consistent with the narrower cybernetic and communication theory idea of information as a measure of the change induced between *a priori* and *a posteriori* probabilities of states of nature before and after the arrival of a message (Wiener 1949).

Whilst information establishes itself in the sphere of common understanding, knowledge derived from it is subjective in nature, and intimately linked to the group of individuals generating it. For example, a folder filled with articles which have never been read and which may be from various disciplines may be regarded as data. Once the articles are read they become information. If the information is then compared and contrasted, further searching strengthens particular understandings and these understandings are then acted upon (through conversation, writing or searching)

it could be said that one knows something about the 'topic' that has been read. Data and information are not regarded as knowledge, mainly due to the lack of interaction and dialogue involved in communicating either.

Knowledge categories

One of the most frequently cited categorisations of knowledge is that of tacit and explicit knowledge. This categorisation originates from work of the philosopher, Michael Polanyi on the tacit dimension. Polanyi (Polanyi 1966), p.4) was of the opinion that we will always know more than we can tell. That is to say that there will always be a part of the knowledge which we have that we cannot express. The tacit dimensions of knowledge relate mainly to embodied skills, where, for example, we may know how to ride a horse, or be excellent at playing tennis but we cannot translate all our skills into words for our colleague (or indeed our competitor) to learn. It is for this reason that this form of knowledge is regarded as *the* key to sustainable competitive advantage and sits at the heart of the knowledge creation process.

Nonaka and Takeuchi (Nonaka and Takeuchi 1995) built upon Polanyi's notion of the tacit dimension of knowledge differentiated clearly between tacit and explicit knowledge. According to these authors, the Western perspective on knowledge is formal and systemic, something that can be expressed in words and numbers. This is referred to as explicit knowledge. The Japanese, however, realize that explicit knowledge represent only a fragment of the collective knowledge. Knowledge is therefore viewed as highly personal, difficult to formalize and communicate. This category of knowledge is defined as tacit knowledge. "Subjective insights, intuitions, and hunches fall into this category" (Nonaka and Takeuchi 1995), p. 8).

Tacit knowledge (TK) is often considered to be an intangible firm resource (Jacobson 1990; Barney 1991; Ambrosini and Bowman 2001) and highly desirable in creating competitive advantage due to its inimitability (Baumard 1999). However, Nonaka (1994), advocates that the key to understanding knowledge creation lies in the ability to make tacit knowledge explicit. This may explain why most knowledge management practices address the explicit qualities of knowledge and focus on

coding, recording and re-use of knowledge in order to build a stock of this competitive resource.

Indeed, more recently (Cowan, David et al. 2000) we have been urged to focus on codified and codifiable knowledge to further our understanding of the economics of knowledge. This approach was soon criticised for its over-simplification and dilution of the complexity of knowledge (Johnson, Lorenz et al. 2002). These critics call for the inclusion of practice or 'knowing' when we want to understand knowledge in organisations. Here the focus is on how *knowledge flows through practice* rather than how it is recorded in written format, which often distracts from practice. The example of excellent scientists is given in this context:

> *'When interviewed about the background for their success as scientists, almost all Nobel Prize winners pointed to their interaction with other and more experienced Nobel Prize winners as a key element in their career.' (Johnson, Lorenz et al. 2002), p. 247)*

This particular response sits comfortably with the approaches of organisation theorists, sociologists and philosophers: valuing the dynamic nature of knowledge yet respecting the need to manage/facilitate its management. It appears that the tension between 'messy' practice-based knowledge and creating competitive advantage from this illusive resource can be resolved in two ways. Some argue that knowledge needs to be made manageable through the codification process (Cowan, David et al. 2000) whilst others (Leonard and Straus 1998) prefer to work *with* rather than distract from its unmanageability. The latter approach has gained considerable support for its construct validity and ontological soundness. However, advocates of this approach often leave questions of practicality unanswered. If knowledge remains tacit how can it be identified within the organisation? Even more so, if knowledge is embedded in action how can it be identified? If knowledge is so intimately personal (Polanyi 1966; Gerard 2001; Johnson, Lorenz et al. 2002) how can we identify the owners and influencers of knowledge in a system?

Our paper addresses the tension between theory and practice and attempts to answer these questions by

1. Appreciating different forms of knowing that influences business success (knowing what, knowing how, knowing why and knowing who)
2. Developing and applying a technique, which captures the dynamic and systemic qualities of knowledge. This technique (Qualitative Politicised Influence Diagrams or QPID) captures all four forms of knowing by examining the system context in which knowledge is used and the roles of users and owners of that knowledge.
3. Using the technique to establish the role of knowledge in the chains of causality which lead to value in the system.

First we provide a brief overview of the knowledge literature and in particular the categorisation of knowledge. The section that follows describes the explicit system technique we used to capture the essence of knowing in practice. We then provide the empirical context within which we explored the notion of knowing and report on the dominant business model within an actual firm. Our methods of data gathering together with the analysis and results are discussed next. Finally we draw conclusions on the use of the QPID model in understanding knowledge and knowing, and here we report on how this advances both theory and practice of working with valuable and intangible resources.

Organisational knowing

Several in-depth accounts of the structure and function of tacit knowing have been presented in the literature (Polanyi 1966; Gerard 2001) and we focus here on different types of knowing that are considered central to a firm's success. Our framework builds upon the work of Johnson, et al. (Johnson, Lorenz et al. 2002) and Arthur & Parker (Arthur and Parker 2003) and classifies knowing into: *knowing what*, *knowing how*, *knowing why* and *knowing who*. It is important for the reader to note that each form of knowing contains both tacit and explicit dimensions and that the act of tacit knowing is central to each.

Knowing what

Here we differ from Johnson et al (Johnson, Lorenz et al. 2002) and state that 'knowing what' is more than just knowing the facts (information) and we relate this in an organisational context to 'knowing what to do'. The awareness of appropriate action is related to a clear picture of what the organisation is about and how future responses/actions will benefit the organisation (Swart 2000). Importantly it is central to organisational memory: knowing what was done in the organisation in the past. For this to happen an individual needs to be integrated into a community in the organisation, be that a project team, department or occupational grouping, and have access to and memory of past organisational responses. In terms of a system-based epistemic taxonomy ((Powell and Bradford 2000) we can equate this with knowledge about the components of the system in focus as opposed to knowledge about major sub-systems or about the system as a whole.

Knowing how

This form of knowing relates predominantly to embodied skill (Durrance 1998) or know-how (Ryle 1949) and is intimately linked to professional competence and experience. Knowing how to do something has an explicit dimension, i.e. instructions for driving a car, and a tacit dimension, i.e. the experience of driving the car. But as all learner drivers will know, you can only become a skilled driver with years of experience. I would also not sign up to compete in Formula One if I am not highly skilled, experienced and talented. The reader may note that we include the dimension of talent here and therefore agree with models of human capital (Bontis 1998; Shadur and Snell 2002; Swart and Kinnie 2003) as a critical organisational resource. We can relate this form of knowledge in the systems taxonomy to what is known about the major mechanisms of control and behaviour in a system.

Knowing why

The ability to know why something has happened, or is going to happen or indeed is happening at the present moment points to underpinning principles and contextual richness. Firstly, I would need to be familiar with the bigger picture. For example understanding why a certain solution has been implemented is related to knowing what has taken place in the organisation at large: we are being taken over by a larger

firm because of the industry conditions and our current financial situation. Secondly it relates to meta-knowledge: not only do I know what to do but I know why it is done. This shows that I understand the underlying systems that support my action. I complete an expense claim form in a certain way *because* other financial systems are related to that particular form and make its processing possible. Thirdly it relates to occupational identity: as a psychologist I know why I should keep information confidential because it relates to the ethical underpinning of my profession.

From a system perspective, this form of knowledge is related to the holistic knowledge about how the major components of a system interact with each other to produce a complex overall effect.

Knowing who

The notion of 'knowing whom to ask' has generated considerable interest in recent accounts on knowledge sharing, knowledge management and knowledge intensive firms. This form of knowing relates to the identification of the owners of knowledge. In other words, knowing who knows what. We acquire this form of knowing through our extended participation in a community and by developing and nurturing our social networks. Although an explicit guide such as skill databases are useful in this regard, it is mainly previous interaction and embedded relationships that guide successful knowledge sharing across boundaries (Swart and Kinnie 2003).

The originality and power of the method on which we report here is in the explicit representation of the 'who' in the system, both in terms of understanding who carries out a system function and who owns, uses or aspires to the knowledge necessary to carry out that role or roles.

Integrating forms of knowing

Knowing, rather than knowledge, can be considered as the key competitive advantage of organisations in the knowledge-based economy (Drucker 1993). It is the ability of organisations to identify and understand each of these individual forms of knowing as well as how they interact that will provide them with an advantage in the market place. This section therefore reviews how the forms of knowing exist as interdependent action-based processes.

Take for example the emergence of Silicon Valley. Here experienced software developers are experts in knowing how to write code. It is this knowing how that makes them a respected member of their occupational community. Interestingly, their competence would not have become 'publicly known' if they had not belonged to a social network. It is in this network that 'knowing who knows' is the key to connecting various experts to create a new start-up. But a few lads in a basement are hardly enough to create the next Microsoft. This throws the light on knowing what to do as well as knowing how to interact with venture capitalists. More importantly it points to an understanding of the changing nature of the software industry since it brings home the criticality of knowing why it is necessary to network, seek funding and to locate yourself in one of those basements with one of those 'who know who, why and what'.

Each form of knowing plays a role in creating competitive advantage. However, understanding their mutual interplay is far more important in beating competitors to a new product/service offering in the market place. It is essential, therefore, that the management of knowledge can appreciate not only the limitations of codification but also embrace and identify each form of knowing that is located within the business system of an organisation.

As we have intimated above, we believe that an explicit representation of the business system in focus allows direct examination of the four categories of knowledge described. Moreover, the ability to examine the connection between individual knowledge users, the epistemic raw material they use and the objectives of the organisation is a powerful one. By making explicit and visible the model of the system under consideration we can, potentially,

- Make clear the role of specific information and knowledge to the success of the organisation
- Understand the total knowledge and information needs of users
- Evaluate the effectiveness of proposed resource expenditure on providing specific knowledge and information to users

And (although we do not make this extrapolation in this paper) our aim is to provide a sound a basis for action on the part of system contributors, owners and managers.

Valuation and non-valuation of Knowledge in systems

If the management processes in an organisation are not directed at managing the forms of knowing that are most valuable to a particular organisation, key resources could be wasted. That is, it is critical for organisations not to find themselves in a position where they are '*managing knowledge for knowledge's sake'* but to direct their KM efforts in such a way that will maximise their competitive position within a network. Although this statement holds some superficial validity, it poses an incredibly difficult question to the KM system of the organisation. Evaluating which forms of knowing are central to the organisation's success is an inherently difficult process for several reasons. Firstly, knowledge is often *hidden*. Organisations are not always aware of the knowledge that is held within their knowledge systems. This is the case of '*knowing what we know*'. Secondly, knowledge is socially constructed through actors within a system and various viewpoints of valuable knowledge may exist. This reason can be referred to as the *multiplicity of value* barrier. Finally, the diffusion of the management of knowledge has traditionally been focused on a best practice model and not on fitting knowledge management to causal organisational systems. Here many organisations implement technology based KM systems or follow well-known KM models that may or may not fit their business model. This final factor is represented here as the *best-practice* barrier.

In the section that follows we make suggestions for a tool that can overcome the 'hidden knowledge', the multiplicity of value and the best-practice barriers.

What would a value-based systemic knowledge tool look like?

Pluralist

It is clear from the socially constructed nature of knowledge immanent in Polyani's work as described above, that any representation of system knowledge must allow of different interpretations of reality by the owners of knowledge in a system. While it may be convenient for System Dynamics workers to espouse a singular, positivist view of the world where a single reality has validity for all participants, this is

unsustainable except in the most narrow confines of definition and is an unacceptably rigid view of the realities of knowledge in any real system.

Representation of actors' frameworks

Similarly, because the knowledge resident in a system is socially and personally constricted, a value based systemic knowledge tool must engage the context of the actors in the expression of their knowledge, so that there must be opportunity for the expression and examination of the inter-relationships between actors through examination of the local polity within which knowledge-owners operate.

Coping with the Tacit/Explicit distinction and working at the Knowledge level not the Information level

Because of the importance of tacit knowledge to the sustainable competitive advantage of the firm it is important to such a systemic KM tool that it should allow of distinctions between explicit and tacit knowledge. Moreover the vital distinction between information and knowledge must be incorporated.

Connecting Knowledge to System to Action

The intent of business is to take action in the world and whether this takes the form of action per se or action in the sense of sensemaking, the intent of any systemic KM tool must respect this imperative for action and, hence should be action-directed in its product.

Representing mechanisms of effect

Any rejection of numerical approaches as a basis for knowledge representation denies us the opportunity for numerical valuation of the usefulness of knowledge. Consequently, we must needs replace such an aspiration by a requirement that a KM representation must be able to show clear causal relationships between knowledge, its owners and users and the business system in which it resides. We may not be able to evaluate in financial terms the usefulness of actor-knowledge dyads, but if we can show clearly the mechanisms by which the knowledge contributes to benefit, we have a basis firstly for a structural argument for managerial attention or action and further, for a localised financially based investigation of cost vs. benefit where possible and appropriate.

SBKM

The quantitative, numerical approach to SD, popular and powerful as it is, has some serious drawbacks for the study of TK and EK in organisations (Coyle 2000; Coyle and Exelby 2000). Numerical SD requires each system component to be described by a variable which is expressible in numerical terms. While this may be wholly appropriate for such things as *revenue*, *profit*, *reliability* or *fuel flow* it is less easy to see the validity of such a requirement when dealing with *competence*, *reputation*, *customer satisfaction* or *quality of service*. One *can* express these variables numerically but there is always a feeling of dissatisfaction at having to shoehorn essentially qualitative matters into a numerical structure (Powell and Coyle 2004).

Other workers in SD have taken a deliberately non-numerical approach, using the concept of a causal map (in essence the Influence Diagram) to capture the system under consideration but then using topological analysis (instead of simulation) to explore the likely dynamic behaviour of the system (Wolstenholme 1990; Powell and Bradford 1998). Figure 1 (an extract from a full system Influence Diagram (ID) discussed later) shows a typical structure from a qualitative system dynamics ID used to study knowledge in a business system.

Figure 1 near here

Figure 1: A loop from a qualitative SD study

Here training investment leads to an increase in competence which leads to improved success in winning business which funds further training. Of course the loop can also work the other way, with falling investment in training leading to a reducing business success. The essence of the qualitative SD approach is the identification of these loop structures in IDs. Examination of the propensity of these loops to grow or shrink allows both the examination of the likely behaviour of the system and also the exploration of candidate policies and their effects on the system behaviour and by examining the rôle of knowledge in those system mechanisms we can establish the valuation of the knowledge in those system mechanisms and by extension in the system as a whole.

The loops do not, of course, stand alone. Figure 2 shows rather more of the ID we shall be discussing later and we can see two other loops, marked B and C which show how competence (driven by training investment) in this firm contributes to business success. We can see that competence contributes to (among many other things) internal efficiency in the firm which reduces job costs (Loop B). The firm in question is an insolvency practice; a reduction in their costs will tend to improve the likelihood of the client firm surviving its difficulties. A record of such successes will encourage future clients to approach the insolvency practitioner since the perception of the competence of the practice will be enhanced. The benefits accrue though increased revenue and are applied to increasing the competence though training. Loop C shows how the internal efficiency affects the ability to manage suppliers which in turn increases internal efficiency (because, for example, their behaviour is more predictable and therefore easier to manage).

Figure 2 near here

Figure 2: Wider effects of competence

A recent extension of the qualitative system dynamics method (Powell and Coyle 2002; Powell and Swart 2003) attaches actors (sometimes called agents) to the causal arrows, indicating who has control over the strength of the connections. This is a very powerful extension because it leads directly to the identification of actions aimed at influencing those actors to use their position in the system in a way which suits us . A recent study of a medical practice(Powell and Liddell 2004), for example, models the way in which patients have to queue for medical consultations and identifies who in the access system controls the critical causal connections, ending up with a list of actions to be taken by the practice to improve access. Examples of actions resulting from the analysis were the training of receptionists in triage and the establishment of senior nursing staff to take simple procedures out of the doctors' consulting rooms.

The variation used in the case study described below examines specifically the data, information and knowledge and the skills and competences needed by each actor in playing their role(s) in the system. The procedure can be simply defined as follows:-

- Establish the explicit system model (the Influence Diagram) in the standard manner
- Using the QPID approach, attach to each causal arrow the actors who, separately or together influence the strength of the linkage represented by that arrow
- Identify the loops in the ID and characterise them according to their strength and speed of operation. This allows prioritisation of effort. Strong, fast loops are analysed before slow weak ones.
- Loop by loop, establish, for each of the actors in each arrow in the loop what information and knowledge is required for them to fulfil that function. Similarly for the skill/competence set needed to carry out that actors function..
- Generally speaking actors will appear in more than one arrow in the diagram. Collect together all the information/knowledge and skill/competence requirements for each actor. These collations then constitute the information/knowledge and skill/competence maps for each actor in that system. Moreover, each element of these related sets can be sourced back explicitly to its origins in a model of the overall organisation and its mechanisms of success.

We now summarise the application of this approach to a real firm of liquidation and insolvency practitioners in the south of the UK

An example (Fanshaw Lofts)

The research context

Fanshawe Lofts Ltd (Anon 2003) is a firm based in Southampton, UK which specialises in insolvency matters. There are three partners and around a dozen supporting staff and managers and the firm has a high reputation in its region for liquidation, corporate recovery and other high level professional accountancy services. The firm is thriving and, with a growing support structure, wishes to identify its knowledge and competence requirements for the future. A study was commenced in Spring 2003 at Fanshawe Lofts' request to map the firm's knowledge and competence sets in order that the three senior partners could identify a knowledge strategy for the future.

Data gathering methodology

The authors carried out an initial clarification of the objectives with one of the senior partners and as a result agreed on a programme of workshops with a senior partner and four managers. The approach was to teach the five informants the method and facilitate their own expression of the system model (the ID) rather than obscure their view of the system by over-involvement. The informants took effectively 9 working hours to produce a first ID together with the attached actor notations. This was then tidied up, correcting some minor errors and lacunae and the final ID is shown as Figure 3. A series of telephone conversations then resulted in the identification of the knowledge and competences associated with actors and the final knowledge/ competence maps were presented to the Fanshawe Lofts partners for their consideration as a management team. The subsequent discussions and actions do not form a part of this report, which is limited to illustrating the practical use of QPID for knowledge mapping. A full case study paper is in preparation (Powell and Swart 2003).

Model results and explanation

Figure 3 shows the ID produced by the group of informants with the actor notation suppressed for clarity. It has about 25 variables, a fairly typical number for a diagram representing a typical business system in this context.

(insert Fig 3 full page near here)

Interpreting these diagrams is best done by tracing the loops. We have already discussed loops A, B and C (Figure 2) . Loop A describes the beneficial effect of training on competence and hence business winning. Loop B indicates a specific mechanism of business winning through the medium of internal cost reduction and loop C describes the way in which internal efficiency and the ability to manage external parties work together.

Figure 4 shows another loop, D, to be found near the centre of Figure 3.

Figure 4 near here

Figure 4: Loop D - Competence leads to improved risk management and improved service

Loop D describes another specific mechanism for success which lies at the heart of Fanshawe Lofts' survivability. As we have seen, the recovery rate for clients supports their reputation and an integral part of recovery rate improvement is their ability to manage the risk of an opportunity. It would not be in Fanshawe Lofts' interest to take on potentially lucrative business if it carried with it significant risk of failure, since their reputation would then suffer.

As final extracts from the full ID, Figure 5 shows loops E and F.

Figure 5 near here

Figure 5: Loops E and F

Here we see another reality of Fanshawe Lofts' business context. Loop E shows, unsurprisingly, that increased competence will lead to an excess of work over capacity which induces recruitment, increasing the number of staff so that the repository of both EK and TK increases. Loop F illustrates that the capacity itself brings in business. Size in and of itself is an advantage in the insolvency business, it would appear.

Examination of Figure 3 will show many other loops [3], some of them concerned explicitly with competences or knowledge and others where the knowledge is implicit within the mechanism captured by the loops. We discuss the extent to which the informants are aware of the role of their knowledge sets in the expressed business model later in this paper.

[3] The diagram can be covered, without duplication of paths, with about a dozen loops

Analysis and observations

Having established common agreement among informants on the business model to which Fanshawe Lofts works, the next step in the QPID procedure is to attach symbols to the arrows in each loop to indicate which persons or groups (both inside and outside the firm) control the strength of connection of the arrows in the loops. If we can influence the strength of these connections we have the chance to push the system behaviour in a direction we favour. We illustrate this by attaching actor symbols to loop D, since this loop has a wide spread of actors both inside and outside the firm. The process of analysis for other loops is similar.

Figure 6 near here

Figure 6: Loop D with actors attached to loops

We see, then, that the informants' view was that the connection between collective competence and ability in managing and identifying risk was controlled primarily by partners (***P***) and managers (***M***), being the constituency which exercised the primary professional skills to make that business judgement. What knowledge and skills might be used to mobilise overall competence in the exercise of the risk assessment? The partners may well need to be aware of specific knowledge held elsewhere in the firm about particular clients. Southampton, although a large city, has only a finite number of firms and business people, and it may well be that a relatively junior member of the firm may have personal knowledge of a potential client. At a more aggregated level, partners or managers may need technical skills to assess the business risk, drawing on historical experience as well as more technical accounting skills. By such argument the specific skills and knowledge of the actors for each arrow are built up and recorded on a spread sheet to be collated later so as to build up a compete list of knowledge and skills needed for each actor to play their part in the system described.

Not all the actors are to be found inside the firm, of course. The arrow *perception of competence > business winning* in Figure 6 is controlled by the partners of Fanshawe Lofts but also by $\boldsymbol{\alpha}$, the advertising agency which they employ and by ***O***, other professionals. Clearly the advertising agency have some control over the extent to which Fanshawe Lofts converts a reputation into won business through its image making and marketing in the national and local media, but it is less easy to see why

other professionals play here as well. The informants were of the clear view that business is brought to Fanshawe Lofts not only through the free will of clients but also through the agency of professional advisers such as lawyers and perhaps existing accountants. Thus these outside professionals control part of the business system that is Fanshawe Lofts. This observation was a significant one for the firm. Until this point in the analysis it had not occurred to them that part of their management of knowledge should include people outside their firm and that it might well be worthwhile investing in improving the skill sets and knowledge sets of these people in order that (in this specific case) they should see more clearly the benefits that the firm could bring to their troubled clients.

Production of the skill set and knowledge sets then follow naturally from a systematic examination of the requirements for each actor in each arrow of the loops of the diagram.

Observations: how the system diagram structures the knowledge

The reactions of the informants to the process were complex. Initially the objectives of the study were (from their point of view) to help them identify explicitly and specifically what they and others needed to do to carry out their functions and further the interests of their firm. We could see this colouring their construction of the model of Figure 3. Variables like *interpersonal competence*, *training* and (quite specifically) *risk management* are examples of system variables put early into the diagram when the QPID process was seen as a recording medium, a way of identifying just the knowing what component of our earlier taxonomy. Soon, however, with guidance from the facilitators their concentration shifted towards using QPID to understand the business system in which they worked. It was not clear to them at that point how the necessary knowledge would emerge.

After the fact, of course, we can see quite clearly how modelling the business system in this way does help to identify knowledge sets. In particular examination of Figure 3 (as a typical example of a business system model) shows how QPID addresses the

identification of all the types of knowledge discussed in the first section, namely knowing what, who, and why, together with the integrated form of knowing.

Figure 3 shows clearly that certain knowledge is not only known to exist by the informants but is also known to have specific attributes. For example, *risk management*, as already discussed, is commonly understood to be an important knowledge/skill set and appears explicitly in the diagram. Similarly *inter-personal communication* is seen as being so important that it appears explicitly. It is readily expressed by the informants without explicit contextualisation. Other information, equally important in the success of the business system, appears only after consideration of ***the role of the actors in the context of the business system***. An example of this is the integrating data gathering skill required of the partners and managers in exercising effective risk management, a different skill from the risk management itself. This system contextualisation of the actors (who are, after all, the executors and repositories of the knowledge and skills) appears to be the key added value of the QPID approach.

In applying qualitative system dynamics to the management of competitive intelligence Powell and Bradford (Powell and Bradford 2000) link the epistemic level to the source of the knowledge (here intelligence information) so that intelligence which derives from appreciation of the system considered as a whole is likely to be more valued than intelligence deriving from knowledge of a variable in isolation. Thus knowledge of the competitor's policy response to the business context is more valuable than information about, say, a technology advance or a price. Knowledge, in a sense, is more valuable than data and derives from a systemic understanding.

We can now see a clear connection between our earlier taxonomy (*knowing what* etc) and the concept of higher epistemic objects (knowledge *vis-à-vis* data) deriving from wider systemic consideration Here, the identification of *knowing what* falls naturally from the systematic examination of the specific knowledge required by actor in the individual contributions they make to the system (the arrows). *Knowing who* emerges from the attribution of actors to the components of the business system and the k*nowing why* from a knowledge of how information and knowledge acts within the system to produce the desired effect, in this case the further success of our insolvency company.

Not only does the QPID method drive out more knowledge than the informants could (and indeed did) express *prima facie*, but it does so in accord with the natural split of that knowledge into the various types of knowing. Additionally, and specifically with reference to our five requirements of a systemic KM tool

- it exhibits plurality of knowledge definition (since the expresio of knwoedge comes form informants directly)
- it respect the context of actors' action, again since the definition and declaration of knowledge is done by actors with regard to their relationship context
- it distinguishes clearly between information and knowledge
- it is demonstrably aimed at an action product
- by virtue of the loop analysis it relates the valuation of knowledge to system mechanisms.

Lastly, and significantly, it is a clearly effective and practical way of capturing the most difficult part of that taxonomy, namely the integrated knowledge required by the organisation for success and growth.

Conclusions

Our observation of the practical use of QPID in knowledge and competence mapping is that it provides a natural and accessible method of relating knowledge within a firm to that firm's situation and objectives. Generally speaking, informants find the method easy to learn and a natural way to explore the organisational system and context in which they operate. Fanshawe Lofts, being a professional services firm, was populated with very well-educated and confident informants. Here we found that with only about two hours of close guidance they were sufficiently fluent in the diagramming method that the researchers could stand back into a facilitation and observation role. With other groups of informants it is necessary to take more of an active role, constructing the system model for them on the basis of the (structured) conversation of the informants.

With all types of informants, however, there is immediate 'buy-in' to the process because the output is clearly connected to activity and action. Fanshawe Lofts' people, for example, immediately saw how their *prima facie* information sets made

sense in the context of how their business worked, so that they received the immediate reinforcement of their judgement that what they thought initially was important to know made sense in the declared business system as it emerged.

Significantly, at the end of the modelling and analysis period with the Fanshawe Lofts people their reaction to what they had discovered was enthusiastic, It mirrored, in a very direct and satisfying way, the *knowing what, how, why and who* structure in that the informants declared a clear sense of context for information and knowledge which they had never before been able to see clearly. Comments such as "That's interesting; I never saw why we needed to know that before" were ubiquitous and indicated a clear contextualisation of knowledge on which basis action can be taken to achieve the aims of the firm.

Further work

While this work has concentrated on the knowledge aspects of EK and TK the associated competence issues have been entrained. The issue of competence sets and in particular the rich connections between these and business strategy in the form of core competence theory are of immense importance to firms. The application of QPID particularly to the core competence identification problem is an immediate and obvious next step, as is the further development of software support to make the collation of actors' knowledge needs into overall knowledge sets easier.

This application of system dynamics in the form of QPID represents an exciting and fertile route for the operationalisation of much of the important work on EK and TK which has addressed within-firm issues, concentrating on resource application and the appropriateness of knowledge management activities in the firm. Connections may well be made in due course with what is known as 'alignment' in strategic IS specification, the process of ensuring that the Strategic IS is configured to match any proposed strategy.

As we have already said, the emphasis in this paper is on system sensemaking and knowledge identification as distinct from the resulting managerial action aimed at nurturing and growing the knowledge necessary for success. This, together with the dual problems of knowledge denial to competitors and knowledge sharing with partners forms a third major thread of further development.

On this latter point, the ease with which QPID identifies knowledge needs both within and outwith the firm allows its application to competitive intelligence where, in contrast with the nurturing management of knowledge within the firm, knowledge can be denied to or protected from the sight of competitors on a more rational basis, allowing more effective application of what can be costly and rare security and data gathering assets.

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