Agility

Tony Brinklow
MPhil, BSc

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Contact:

Tony Brinklow
Brighton Business School
University of Brighton
Room 145
Mithras House
Lewes Road
Brighton BN2 4AT
E-mail: a.brinklow@brighton.ac.uk

"It ain't what you don't know that gets you into trouble.
It's what you know for sure that just ain't so."

Mark Twain

Abstract

Strategic certainty is unattainable, an enterprise has little option other than to sense and respond to change; an aspiration for which the term ‘agility’ is adopted. One could argue that agility should inform every aspect of decision-making, activity and structure. While this claim might resonate with rhetoric familiar to us all, there is a serious point to be made. The future is unknowable and choices have to be made for which the outcome is uncertain. Moreover, the available choices are mediated by the ability of an enterprise to apprehend and comprehend its environment. The facility to engage with an environment depends, inter alia, on the repository of knowledge available to an enterprise. More than this, an enterprise must learn to create, exploit and discard knowledge. While we may prefer to think of knowledge as a stable and reliable resource, quite often it is elusive, amorphous, paradoxical and transient. These features present considerable cognitive barriers that can only be surmounted by a sustained commitment to embrace the dynamics of knowledge creation.

What exactly does this mean? Change (and its implications) may not be revealed fully to an agent (or agent community); comprehension is thus impeded. The veracity of knowledge is compromised and its value diminished; a circumstance that may expose an enterprise to threat or missed opportunity. In extreme cases, the edifice upon which knowledge is posited may be plunged into turmoil. In any event, an enterprise is deprived of agility essential to corporate vigour and endurance. There is little option other than seek to restore a repository of knowledge to prior efficacy and so inform a return to agility. This is rather to treat change as an isolated event. In reality, of course, change is ubiquitous and associated by a complex web of connectivity. We might therefore begin to think of a repository of knowledge as contingent and never complete. Perhaps agility will never be more than an aspiration.

The intention of this paper is further to explore agility and its dependency on the cyclical nature of knowledge creation and exploitation.

Introduction

The material presented in this paper seeks to achieve two objectives: to propose a definition for agility and explore its pivotal dependency on a vibrant repository of knowledge. We are now all familiar with the limitations of the 'command and control' school of management when confronted with environments exhibiting turbulence and uncertainty; characteristics of both the corporate and public sectors. We know also that enterprises are compelled to respond by embracing adaptability and agility. While the terms have similar meaning, adaptability has a narrower focus and is concerned primarily with modification to make fit for purpose. Agility has a broader remit: for the purposes of this paper, agility is defined as 'sensing and responding to change'. From this definition, agility depends clearly on the skills and knowledge available to agent communities contained within an enterprise and its environment. Agility could be considered to flow from a vibrant repository of knowledge. The focus of this paper is to deconstruct the definition of agility and explore its association with the creation and exploitation of value embedded in knowledge.

The first section offers a deconstruction of the term 'agility'. To begin though, the term 'enterprise' is deconstructed to yield its essential taxonomy and the core concept of 'agent'. Attention returns to the meaning of 'agility' by first establishing its purpose. From the earlier definition, agility aspires to respond to change in some way that is both appropriate and sustainable; an aspiration requiring recourse to metaphors such as chaos and complexity. The section continues by providing an account of perception and conception with a view exploring how an agent community might apprehend and comprehend change. There follows a brief account of how sensing and making sense of change might inform a response strategy. The subtext of this section suggests that both sensing and responding to change are mediated by knowledge available to the agent community. The section concludes by stressing the dependency between agility and access to a vibrant repository of knowledge.

The second section addresses the emergence of knowledge. The section begins with a brief survey of familiar accounts of the origins of knowledge and its association with data and information. The enquiry proceeds by exploring further the motivation and commitment to create knowledge. A distinction is drawn between perceptual and conceptual knowledge and their dependency on the cognitive ability and commitment of the knowledge creating agent.

The third section presents an account of the anatomy of knowledge: a term adopted for this paper to describe the ascendancy of knowledge through various cognitive forms until it can be represented with semantic rigour. The description of anatomy is extended to cover the use of domains to establish theory from which to verify and contextualise knowledge. There are, of course, many cognitive barriers to thwart mature expression and consign knowledge to a miasma of incomprehension and inarticulacy. This section adopts a rather static view of knowledge. The anatomy of knowledge is important to an enterprise, as lucidity and maturity of expression confer utility and ease of dissemination; qualities potentially depleting value and exposing a dynamic perspective to the management of knowledge. The following sections explore the dynamics of knowledge management.

The fourth section looks briefly at the concept of a knowledge asset. Quite simply a knowledge asset provides opportunities for gains in effectiveness and efficiency; but this is not the whole story. Disorder in a system serves to diminish the value of a knowledge asset over time; a phenomenon resonating with the concept of entropy. This analogy forms the basis for exploring further the dynamics of the knowledge creation cycle and establishing an agenda for agility.

The fifth section explores the lifecycle of a knowledge asset. As one might expect, benefit granted to an enterprise is a transitory and variable feature of a knowledge asset. In the first instance, a knowledge asset must be subject to significant elicitation, articulation and analysis

before it can confer benefit. Thereafter, in all likelihood, events conspire to ensure that any benefits accrued from the knowledge asset diminish over time; i.e. entropy increases and value decreases. We make think, therefore, in terms of a knowledge asset lifecycle with respect to its benefit to an enterprise; a lifecycle characterised by detours, barriers, setbacks and (hopefully) episodes of competitive advantage. The metaphors of chaos, order and complexity are applied to understand better the trajectory of a knowledge asset in terms of the value it bestows on an enterprise.

The sixth section investigates how the lifecycle of a knowledge asset may be extended; i.e. how the residual value of a knowledge asset may be preserved. Entropy serves to deplete a knowledge asset of value; and, in so doing, diminish the benefit to an organisation and truncate its lifecycle. Preservation of value would seem to be essential to optimising and exploiting the benefit presented by a knowledge asset. We focus here specifically on the adoption of a systemic modelling convention as a means of representing a knowledge asset such that any inherent value is protected and available for exploitation within the purview of an extended lifecycle.

The paper concludes by indicating an agenda for investigating further how knowledge creation, representation and exploitation can preserve essential enterprise agility.

1 Enterprise Agility

A fundamental contention and motivation for this paper is that enterprise agility provides a focus and context for considering the knowledge lifecycle. The concept of a 'lifecycle' suggests that knowledge emerges, is utilised and expires over some timeline. The capacity for agility influences the ability of an enterprise to refresh, exploit and discard knowledge in the pursuit of competitive vigour.

Enterprise agility is thus a concept that bears some scrutiny. An enterprise may quite simply be described as an assembly of resources mobilised to achieve some purpose; deconstruction suggests an enterprise is simply an orthogonal alignment of agent, event and resource (Dunn et al (2005)).

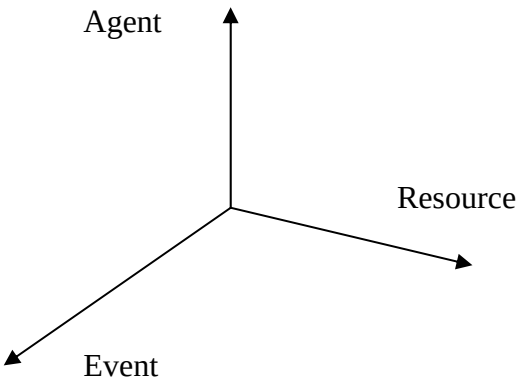

Figure 1 The enterprise taxonomy

The concept of agent merits some further explanation. An enterprise is populated collectively by communities of agents. Dennett (1996) proposes that primitive agents merely perform actions, while human (intelligent) agents perform intentional actions sensitive to 'variety, opportunity, ingenuity and deviousness'. Moreover, 'a choice of action is determined by a

consideration of beliefs and desires'. Alternatively, Magee (2001) defines an agent simply as 'the doing self'. Dunn et al define agents to be operating units participating 'in the control and execution of events' with events the activities (changes of state) needed to be 'controlled, executed and evaluated' and resources the 'things of economic substance provided or consumed by an enterprise's activities'. Within this taxonomy, we now proceed to deconstruct the meaning of agility.

1.1 The unpredictable nature of change

For the purposes of this paper, change is described as the consequence of an event resulting in a shift (or disruption) in the equilibrium between an enterprise and its environment. Change may diverge widely both in terms of its essential characteristics and impact on an organisation; for example, a change may be scarcely discernable or cataclysmic, local or remote, discrete or continuous, and it may even create a 'tipping point' leading inexorably to a catastrophic redefinition of an environment.

Stacey's 'Chaos Theory of Organisation' (Stacey, 1993) provides some interesting insights into change and the enterprise. In challenging many of the fundamental precepts of conventional approaches to strategic management, Stacey argues that 'webs of non-linear feedback loops' define both the fabric of an enterprise and its connections with its environment (other enterprises). Stacey explores further the challenges presented by the unpredictable nature of change. Of primary importance is the claim that enterprises can address unpredictable change by operating in states of chaos or bounded instability (far from equilibrium). In other words, an enterprise must navigate a dynamic trajectory between the competing forces of stability and instability. A successful enterprise is characterised by the ability to respond to 'irregular cycles and discontinuous trends' that conform to qualitative patterns of 'fuzzy but recognisable categories taking the form of archetypes and templates.'

Agility is of marginal significance when a response to change relies simply on adherence to some strategic prescription. Where no such prescription is available, agility permits strategic focus to emerge through a process of self-organisation from the application of archetypes, analogies and other cognitive devices. The contribution of knowledge to self-organisation is examined in more detail in the remainder of this section.

1.2 Sensing and responding to change

Agility is defined as sensing and responding to change. For an environment exhibiting significant complexity, the prospect for an agent (or community of agents) to detect or interpret any manifestation of change is necessarily compromised. The outcome of sensing change is more likely to be a matter of 'nuanced' awareness rather than the categoric identification proposed by conventional management edicts.

So how does the agent respond; a nuanced assessment of change may well render the agent vulnerable to error when formulating a response? A good starting point is to acknowledge that responding to change is very often an uncertain and hazardous undertaking. The agent may be required to respond to change where knowledge is incomplete and ambiguous. A response depends now on the agent's powers of perception and cognitive acuity; i.e. the ability to make sense of change. To understand the meaning of 'sense-making' relies on first exploring basic classifications of knowledge (Section 1.4 provides a brief account).

1.3 Making sense of change

Sensing and responding to change takes many forms. Trivially, a change may not be sensed and so no response is forthcoming. The more interesting case is where change is sensed and the agent strives to formulate a response. The agent may choose not to respond (this is quite different from ignoring the change) and await the emergence of future events; alternatively, the agent may detect an obscured significance embedded in the change and devise an emphatic response (one might reflect here on the opportunism of the entrepreneur or the heightened awareness of an expert). More commonly, responses to change are less easily characterised; the agent is confronted with a kaleidoscopic ensemble of choices such as: whether (or not) to respond, how to respond, when to respond, where to respond and so on. How is the agent to formulate a response exploiting best the sense made of the change?

1.4 Knowledge and sense

Drawing from Kantian analysis, knowledge is argued to be drawn either from experience or reason, i.e. it is either perceptual or conceptual. Perceptual knowledge is derived from our present environmental reality and mediated by our senses; as Boisot (1995) contends, perceptual knowledge is rooted in what you can 'see, hear, feel and touch'. Claxton (1997) uses the phrase 'Perception without Consciousness' to distinguish further between conscious and unconscious perception, where unconscious perceptions are reserved for objects, events and sensations that have not entered our consciousness. Conceptual knowledge (or schemata) provides the concepts from which to make sense of perceptual knowledge through conceptual categorisation (Rosch, Boisot). Perceptual and conceptual knowledge are considered to form a symbiotic alliance in reducing the complexity of making sense (in our case) of the interaction between an enterprise and its environmental reality.

However, our knowledge on any domain is only ever, at best, contingent and imperfect. In an attempt to describe the frailty of perception, Midgley uses an aquarium as a metaphor to reason about the nature and limitations of perceptual knowledge (Midgley, 2004). A domain is represented as an aquarium where an assortment of fish is observed through a set of randomly distributed windows of variable size, shape and opacity. An agent has access to one of these windows, with each window revealing a fragmentary and transitory perception of the collective reality: the domain theory or ontology. Gladwell (2005) provides a supporting view of perception by asserting for novice and expert alike, perceptual sensing may be influenced by 'thin slicing'. Perception may be fragmented further by the 'adaptive unconscious' focusing only on those details from a domain considered important by the agent; a judgement that may be influenced by the predilections of the observing agent.

Thus from a contingent and partial perception of reality, the novice agent might fail to sense impending change, while the expert agent may be expected to apprehend completely the imminence and significance of a change. The expert has the distinct advantage of access to a repository of conceptual knowledge from which to interpret and evaluate the perceptual content of the 'thin slice' of reality. Cognitive artefacts such as archetypes, analogies, metaphors and models form the conceptual knowledge from which to articulate perceptual knowledge, i.e. to make the transition between tacit and explicit knowledge (Polanyi and Prosch, 1975, Nonaka and Takeuchi, 1995). To conclude, for an agent to make sense of change, access is required to a repository of both perceptual and conceptual knowledge.

This section has sought to establish the pivotal role of knowledge in enabling an agent to sense and respond to change. The next section focuses on the emergence of knowledge.

2 The emergence of knowledge

Agility depends on the emergence of sufficient knowledge to sense and respond to change. The emergence of knowledge is explored in this section with a view to identifying its origins and precarious fruition.

The Concise Oxford Dictionary offers the following definitions: awareness or familiarity gained by experience; a person's range of information; a theoretical or practical understanding of a subject, language, etc; the sum of what is known; true, justified belief, certain understanding as opposed to opinion. As with any substantive concept, it emerges that knowledge is a multi-faceted and interconnected entity. At some level of abstraction, knowledge represents what is known and is related to concepts such as awareness, familiarity, experience, information, theory, practice, understanding, belief and judgement, i.e. knowledge has context. But what exactly is this context and what is its intrinsic relationship to knowledge?

Cleveland (1982) asserts that T.S. Eliot's poem 'The Rock' was the first reference to suggest some context for knowledge with the following extract:

Where is the life we have lost in living?
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?

While Eliot laments the loss of wisdom and knowledge, a relationship is implied quite clearly between wisdom, knowledge and information.

Following in Eliot's footsteps, Checkland (1982), Ackoff (1989), Howell (1989), and Checkland and Howell (1998) all seek to provide a structural definition for knowledge, but fail to persuade. Perhaps a more convincing account is provided by the DIKW hierarchy (see Figure 2). Bellinger *et al* (2004) define the hierarchy to be simply data, information, knowledge and wisdom, with understanding achieving the transition through the categories.

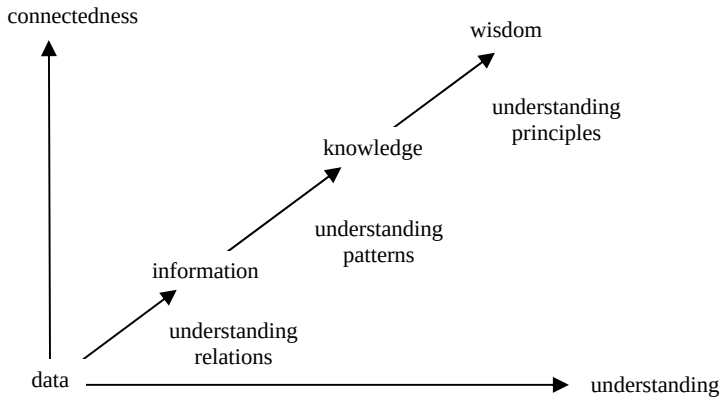

Figure 2 The DIKW hierarchy (Bellinger et al, 2004)

The key to the hierarchy is achieving levels of understanding. In common with the earlier approaches, data may be viewed as some disconnected collection of facts about a domain that have little intrinsic interest. Information emerges from the domain when relationships between the facts are established and understood; this is somewhat richer than simply establishing a context for the facts. Knowledge emerges when the patterns of relationships are identified and understood; a quite different perspective from size and longevity. Finally wisdom (the pinnacle of understanding) uncovers the principles describing the patterns of

relationships. This approach is much more encouraging and yet fails still to capture the essence of knowledge. Another perspective is required, and for this we turn to the Knowledge Management community.

Nonaka and Takeuchi (1995) offer three observations concerning the relationship between knowledge and information:

- Knowledge, unlike information, is about beliefs and commitment; it is a function of perspective and intention
- Knowledge, unlike information, is about action; it is purposeful
- Knowledge, like information, is about meaning; it has context and connectedness.

Knowledge is considered to be 'a dynamic human process of justifying personal belief towards the "truth" '. Bateson (1979) and Dretske (1981) hold that information carries signals providing the basis from which to elicit and express knowledge. Information therefore is a flow of messages yielding knowledge 'anchored in the beliefs and commitments of the holder'.

Boisot (1998) recognises the imperative to establish the distinction between data, information and knowledge, and provides the following definitions:

- Data is simply the discernable difference between alternative states of a system.
- Information is data that modifies expectations or condition readiness of the observer. The more expectations are modified, the more the information quotient of the data.
- Knowledge is the set of expectations and a disposition to act held by an agent.

In short, knowledge is modified by the arrival of new information extracted from data generated from phenomena. However, it is necessary also to reflect on the beliefs, expectations and commitment of the agent, as these factors establish a filter through which an agent creates and exploits knowledge.

The emergence of knowledge should not be considered a seamless and unfettered transition. Perception is contingent and mediated by the senses of an agent, while the efficacy of conceptual knowledge depends on the cognitive tools and artefacts brought to bear by an agent. Following Boisot, an agent seeks devices to economise on the cognitive effort required to process data and extract information relevant to the creation of knowledge. To understand better the emergence of knowledge, it is necessary to address the anatomy of knowledge and the organisation of knowledge into domains.

3 The anatomy of knowledge

How does one address the anatomy of knowledge? To begin, one must recognise there are different modes of knowing (Boisot, 1995), with each yielding its own distinctive anatomical features. To illustrate the different modes of knowing, Boisot provides the epistemological (E)-space delineated by dimensions representing the processes of coding and abstraction (see Figure 3). Position and trajectory within the E-space reflect both an agent's acquisition of cognitive assets and the ability to apply coding and abstraction strategies to an economic representation of knowledge. The E-space allows Boisot to show the different levels of knowing as a path progressing through conceptual and
perceptual categories.

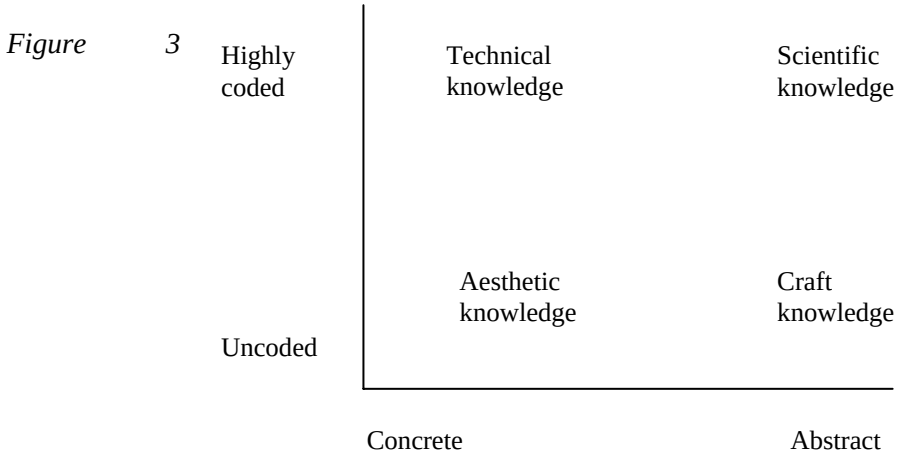

Figure 3 *Boisot*

Epistemological (E)-space

Abstractions and coding conventions are sought to define the conceptual and perceptual categories respectively. Edelman (1987) holds that coding choices are drawn from *local, immediate* stimuli while abstractions are drawn from *non-local* stimuli. Boisot continues by citing Churchland's (1989) claim that mature perceptual and conceptual categories yield 'law-like regularities' (nomological generalisations).

Perceptual and conceptual activity both are held to utilise a minimum of the agent's data processing resources. Following Bruner (1956 and 1968), coding reducing the quantity of data to be processed while abstractions reduce the number of categories through which data is to be managed. Boisot concludes that abstractions yield the categories capturing the essence of a perceptual attribute.

We might expect therefore, following Polanyi (1958, 1966), Boisot's three modes of knowing exhibit different anatomical structures (See Figure 4). The first mode of knowing, 'the ineffable domain' represents knowledge resisting any attempt at coding and deals with concrete experience rather than abstract concepts. However, Nonaka (1991) asserts new knowledge originates from tacit, subjective and insights of agents (or small agent communities) and is disseminated to extended agent groups though a variety of cognitive artefacts. In accordance with Boisot, Nonaka confirms tacit knowledge is 'below the level of awareness' and therefore difficult to communicate.

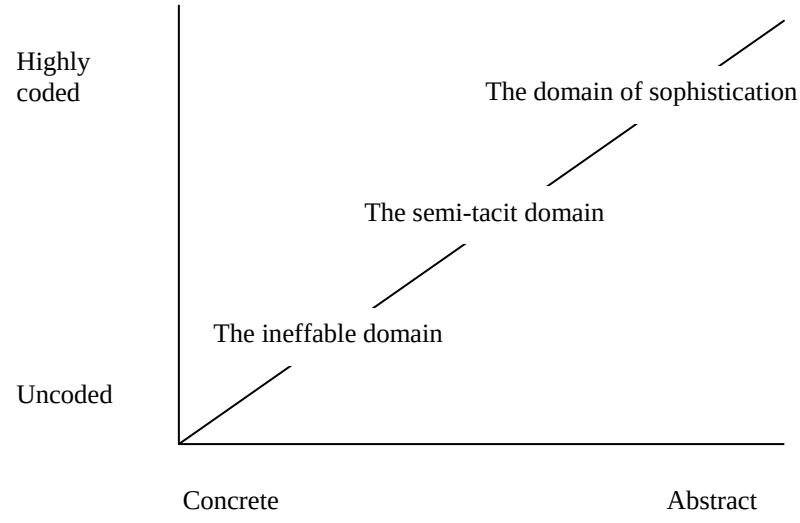

Figure 4

Boisot's modes of knowing

Boisot labels the next mode of knowing as the 'semi-tacit domain'. In this mode, agents have a variety of 'non-specialised' words, symbols, codes and categories from which to engage in natural discourse. Boisot avers any loss of coded or abstract expression is offset by gains in communication; also, large tracts of experience can be exposed to collective understanding with comparatively little effort. In this domain, aspects of tacit knowledge are rendered explicit.

Finally, the 'domain of sophistication' draws primarily on highly coded and abstract categories. Here, tacit and explicit knowledge are rendered disjoint as data embedded in earlier attributes and categories is lost. Boisot declares that for the domain of sophistication, a variety of cognitive artefacts 'shape thought explicitly through procedural and inferential rules'.

Tsoukas (1997) reminds us the Polanyi does not consider tacit and explicit knowledge to be discrete. Tacit knowledge is embedded in all knowledge, and is transformed into an explicit state through a form of social interaction called 'knowledge conversion' (Nonaka and Takeuchi, 1995). Returning now to the anatomy of knowledge, one might therefore think of knowledge taking many forms on its trajectories between tacit and explicit states, and one might hope also for a cognitive thread or trail linking the various forms.

3.1 Archetypes

In so much as one can speculate at all on the content of tacit knowledge, one might turn to Jung's archetypes forming collective unconscious from which complexes are derived in the personal unconscious followed by actualisation in the conscious (Stevens, 1994).

Within the realm of systems thinking, Goodman and Kemeny (1994) define an archetype as 'as nothing more than a mental model made visible' although they might add helpfully that the structures enjoy some commonality among an agent community. Archetypes are available to reflect simultaneously on events, patterns of behaviour, systems, and mental models. Hypotheses may be applied to the mental model by introducing, relocating and removing nodes and links associating the nodes.

When an enterprise is defined by some constellation of archetypes, learning may become focused on breaking through organisational gridlock (Kim, 1993). Through the judicious use of archetypes to identify and define the systemic structures that describe corporate behaviour, organisational learning is achieved by:

- developing a shared vision to inform the redesign of systemic structures
- exploring mental models and team learning to confirm assumptions underlying organisational behaviour, culture and beliefs
- performing scenario planning to evaluate assumptions about the future
- developing a vision and learning to see the world from a creative and interdependent perspective, and not merely from a reactive viewpoint

An archetype may be considered an evolving model or pattern of object relations associating objects with activities forming mental representations of reality. While archetypal forms may enjoy stability and exhibit robustness under different transformations, minor differences in personal experience result in actualisation (the making real) of the archetype being unstable across an agent community.

Senge (1990) considers archetypes to be more than mental models made visible; "for all their flaws, mental models provide a fertile source of knowledge that may be penetrated through

the use of archetypes." A more likely explanation is that knowledge emerges discontinuously from mental models through a series of inferential leaps. Coupled with this emergence of knowledge is the reconstruction of new mental models from previous unconscious constructs that have suffered some disturbance of their earlier content.

For all their potency, archetypes provide only rudimentary forms of expression with which to communicate knowledge with any degree of precision. One might expect knowledge for which only archetypes are the available form of expression to languish in Boisot's 'ineffable domain'. To venture into Boisot's 'semi-tacit domain' and beyond to the 'domain of sophistication', metaphors, analogies and models must be used to express knowledge.

3.2 Metaphors

Arguably, the most familiar and potent use of metaphor available today is Lovelock's Gaia (Lovelock; 1979, 1988, 1991a, 2000). Lovelock defines Gaia as a 'thin spherical shell of matter that surrounds the incandescent interior – it begins about 100 miles below the surface [of the earth] and proceeds another 100 miles outwards through the ocean and air to the edge of space.' The metaphor of a self-regulating biosphere representing the 'living earth' is central to the notion of Gaia. Lovelock (2006) contends that metaphor address phenomenon which are otherwise 'inexplicable in words'.

Returning to Boisot's E-space, the use of metaphors represents a cognitive endeavour signalling a transition to the 'semi-tacit domain'. From Nisbet (1969), Nonaka and Takeuchi note much tacit knowledge is only expressible as metaphor, i.e. by "understanding and experiencing one kind of thing in terms of another" Lakoff and Johnson (1980). According to Donnellon, Gray and Bougon (1986), metaphors enable perceptive and intuitive understanding by creating new realities that may reconcile 'differences in meaning'. From Richards (1936), Nonaka and Takeuchi reason that metaphors encourage the creation of networks of (possibly) remote concepts, and the association of concrete concepts to abstract expressions. Furthermore, the metaphorical process makes the transition from concrete to abstract concepts. Lakoff and Johnson argue that abstract concepts are understood in terms of prototype concrete processes.

It is arguable whether metaphors make the transition from the 'ineffable domain', but certainly they yield the abstract concepts required for the 'semi-tacit domain'.

3.3 Analogy

Nonaka and Takeuchi define the role of analogy as the reconciliation of contradictions inherent in metaphors (the source of their potency). Analogy strives therefore to add rigour to the definition of a concept by appealing to its functional and structural characteristics. To paraphrase Nonaka and Takeuchi, analogies enable the agent to understand the unknown through the known and transform images into logical models. Analogies are used to construct logical models of a concept and reconcile residual contradictions. Stacey goes further to claim reasoning by analogy empowers the self-organising process to yield emergent strategic directions.

According to Hamel and Prahalad (1994), the rate of innovation varies across different industries. From this premise, they argue that enterprises can 'steal a march on competitors' by seeking relevant analogies from other industries. From 1994, they provide an example of the supermarket yet to exploit the home delivery facility provided by many other service industries. The supermarket 'of the future' would need different physical facilities, IT infrastructure, locations and skills. They recognise the difficulties inherent in describing the new, unfamiliar enterprise; and so appeal to the familiar and tangible metaphor (provided by other industries) to describe that which is unfamiliar and intangible.

Possibly the metaphor, and certainly the analogy permit the agent to reason within the 'semi-tacit domain'. Agents now have at their disposal a variety of symbols, codes and concepts with which more simply to disseminate knowledge. Within this domain, the impenetrability of tacit knowledge has been breached in some limited respect and rendered explicit through metaphor and analogy.

3.4 Systemic Models

Lovelock (1991b) describes a model as a representation of a real system providing sufficient detail to capture essential concepts while omitting incidental detail. We might think, quite legitimately, of archetypes, metaphors and analogies as models 'made visible'. However, the approximation and ambiguity of the icons forming the lexicons for these models diminishes their efficacy and ease of dissemination.

Before proceeding with systemic modelling, it is helpful to introduce the concept of categories. According to Boisot, categories represent the conceptual frameworks from which to interpret perceptual knowledge. Conceptual data is derived from organising perceptual data into abstract categories. Abstraction is considered a form of reductionism where the few represent the many to shape the categories employed to interpret phenomena. Rosch's work on categorisation argues for a systemic modelling convention to provide both clarity of expression and semantic rigour (Rosch, 1978). Systemic modelling should aspire to economy of cognitive effort and clarity of expression while mapping the 'perceived world structure as closely as possible'. A systemic modelling convention thus determines membership of categories through the specification of prototypes. Returning to the earlier definition of an enterprise, one must expect a systemic modelling convention to define prototypes addressing agent, action and structure. The semantic rigour attendant to a systemic modelling convention is deemed to add clarity and consistency to discourse and dissemination.

3.5 Knowledge domains

Categories lend structure and cohesion to conceptual knowledge, but more is needed to sustain the emergence of explicit knowledge. Specifically, a universe of discourse is required to develop theory and establish an ontology; a role fulfilled by a (knowledge) domain. More prosaically, Gardner et al (1998) propose that domains 'serve as explanatory structure for expectations regarding a situation'.

Knowledge domains are formed from some aggregation of abstract and codified content constituting an ensemble of concepts. One might anticipate the ensemble to be cohesive and exhibit a distinct focus; qualities indicating the presence of a domain. Also, within a domain, knowledge is represented consistently according to the semantics of a systemic modelling convention. (Chandrasekaran et al, 1999) hold that concepts are held within a domain through the adoption of the following propositions:

- There are *objects* in the world
- Objects have *properties* or *attributes* that can take values
- Object can exist in various *relations* with each other
- Properties and relations can change over *time*.
- There are *events* that occur at different *time instants*.
- There are *processes* in which objects participate and that occur over time.
- The world and its objects can be in different *states*.
- Events can *cause* other events or states as *effects*.
- Objects can have *parts*.

Membership of a domain is thus established through conceptual cohesion according to structural compliance with Chandrasekaran's propositions. Shared adherence to behavioural or structural patterns may enhance further any claims to membership of a domain. Finally, a domain is recursive in the sense that the embedded knowledge assets may be expressed at various levels of conceptual granularity. Rosch enriches further the notion of a domain. Candidates for membership of a domain should aspire to maintain clarity while preserving richness of content. Also, the domain semantics should aim to preserve clarity of expression while mapping the "perceived world structure as closely as possible". The semantics provide for the specification of prototypes from which to determine membership of categories of concern. A mature modelling convention may be so defined.

Both Boisot's 'semi-tacit domain' and 'domain of sophistication' draw on various forms of systemic modelling. Each form is supported by its own semantic assumptions and priorities. For the 'semi-tacit domain', the priority is probably for discourse and communication over precision. For the 'domain of sophistication', however, more stringent requirements are imposed on the semantic edifice supporting the systemic modelling convention.

In contrast, the more rarefied 'domain of sophistication' places greater emphasis on the diversity and rigour on systemic expression; features determined by semantic rules specifying the modelling convention. Of particular interest here is the iconography used to express perceptual and conceptual knowledge. Boisot (1995) reminds us that 'perceiving is a coding activity and conceiving is an abstracting one'. Perceiving and conceiving are parallel activities aimed at reducing a cognitive burden by shedding peripheral data. Coding economises on data by assigning it to categories and 'dealing only with the latter', so discarding much assigned data. Abstracting achieves economies by reducing the number of categories to be employed. An effective symbiosis of coding and abstracting may yield enduring cognitive assets of value to an enterprise.

Boisot reserves the 'domain of sophistication' for drawing primarily on highly coded and abstract categories. For the agent, tacit and explicit ways of knowing become disjoint as novel modes of thought become possible; the capacity for abstract symbolising skills resist intuitive understanding. Rather than simply represent categories, systemic icons 'shape thought explicitly through procedural and inferential rules'.

3.6 Concluding observations on the anatomy of knowledge

Knowledge may exist anywhere on the spectrum defining the cognitive trajectory between tacit and explicit knowledge. Tacit knowledge is thought to reside in the unconscious and therefore elude expression. Archetypes may be available to provide a focus for reflecting on tacit knowledge. As knowledge emerges from the unconscious and commences its trajectory to an explicit state, cognitive artefacts such as metaphors and analogies provide the anatomical fabric of knowledge. Systemic models replace the earlier 'mental models' as the means of expression when knowledge emerges eventually into an explicit state. Although tacit knowledge is considered to be embedded in (rather than apart from) explicit knowledge, advanced use of systemic models may result in explicit knowledge becoming dislocated from its tacit origins.

The anatomy of knowledge depends on the degree of elicitation. The epistemological status of knowledge consolidates as it ascends the anatomical strata and advances both in utility and the capacity for dissemination. Ascent of the anatomical strata reflects supersedence of cognitive antecedents; a process Deutsch (1997) might describe as 'replacing the arbitrary and complex with the coherent, elegant and simple'.

4 The knowledge asset

The previous sections address the emergence and anatomy of knowledge. In the absence of insurmountable cognitive barriers, knowledge might be expected to emerge in some mature anatomical form; a not inconsiderable achievement. The question remains: is this hard won knowledge of any use to an enterprise? Boisot cautions that knowledge need not be an asset. How can this be so?

To become an asset, Boisot (1998) holds that knowledge assets are those accumulations of information structures "that yield a stream of useful services over time while economising on consumption of physical resources." We know now that change serves to undermine the value of a knowledge asset. Boisot appeals to the second law of thermodynamics to explain how the value of knowledge assets diminishes over time. Key to this explanation is the concept of entropy: the measure of the amount of disorder in a system. Unlike a closed system, Boisot explains that for an open system: 'a given quantity of work can be made more useful'. Following Shannon's work (1949), Boisot speculates that 'knowledge and entropy stand in some inverse relationship to each other'. Quite simply knowledge minimises the consumption of existing resources while providing opportunities to consume new resources. For a knowledge asset, an agent might seek to prolong a period of minimum entropy while forestalling the transition to maximum entropy.

The value of a knowledge asset is transient and sensitive to change. Where a knowledge asset is propelled towards the zone of maximum entropy and minimum value, there is little option other than to refresh the repository of knowledge available to the agent community. In so doing the agent embarks on another odyssey of knowledge creation. This is a rather artificial and contrived account of a probable reality. One might expect (hope for) an agent community to contribute to an endless ferment of knowledge creation.

In any event, only environments characterised by dormancy and stasis are placed to preserve the value of knowledge. One is hard pressed to conceive of any such environment in the corporate and public sectors of today. A more likely scenario for is even before knowledge has emerged sufficiently to confer value it is under assault from entropy and change. The next section looks more closely at the lifecycle phases of knowledge creation, exploitation and disposal.

5 The knowledge asset lifecycle

Implicit in earlier sections is the suggestion that knowledge may be created, reconstituted or discarded in response to or anticipation of change. The transitional nature of knowledge suggests the existence of a trajectory delineated by states expressing a lifecycle. There follow two accounts of the knowledge asset lifecycle trajectory.

5.1 Nonaka and Takeuchi's Spiral of Organisational Knowledge Creation

For Nonaka and Takeuchi (1995), knowledge is believed to be created simultaneously in a cyclical trajectory between ontological and epistemological planes, with spiral progression defining the conversion and mobilisation of tacit knowledge (see Figure 5). In broad terms, ontology is taken to address the nature of being and reality, while epistemology explores the theory of knowledge with respect to validating what may be accepted as expressions of being and reality. Ontology is adopted to denote the dimension that represents the dissemination of knowledge throughout the diversity of strata describing an organisation. The orthogonal dimension of epistemology represents the dynamic relationship between tacit and explicit knowledge; in particular, the mutuality of tacit and explicit knowledge creation.

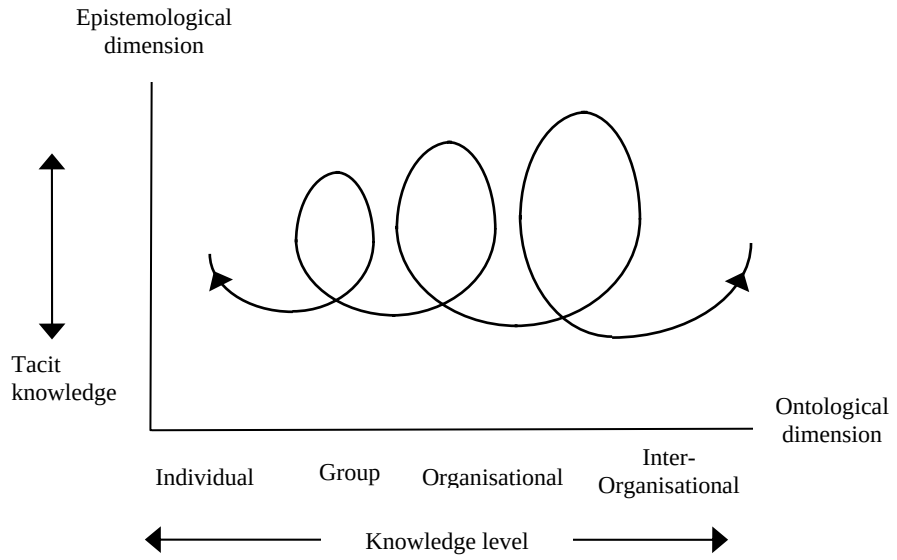

Figure 5 Nonaka and Takeuchi's Spiral of Organisational Knowledge Creation

5.2 Boisot's I-space trajectory

For Boisot, the definition of a knowledge asset lifecycle is linked inextricably with the many trajectories that may be pursued within the I-space. The definition of value is central to understanding the lifecycle of a knowledge asset and the trajectories available within the I-space. Boisot contends that the value of a knowledge asset is a function of its scarcity and utility; quite simply, the greater the scarcity and utility of a knowledge asset, the greater the value. We may think in terms of a knowledge asset lifecycle commencing when it first acquires value and terminating when it surrenders any vestiges of value.

Value is acquired when the knowledge asset makes the transition from a concrete to an abstract state, i.e. knowledge becomes at once both expressible and shareable (but at the cost of shedding richness and meaning). During this transition, knowledge becomes available for promulgation to agent communities within the enterprise and beyond to the external environment. The very act of promulgation poses a threat to the scarcity and utility of the knowledge asset, i.e. to its inherent value. It should come as no surprise that entropy arising from change (in its myriad manifestations) contrives also to divest knowledge of any value. An agent community has therefore a limited opportunity to exploit a knowledge asset. Boisot divides the I-space into three zones (see Figure 6): the zone of chaos where entropy is at a maximum and value at a minimum; the zone of order where entropy is at a minimum and value a maximum; and the zone of complexity where value is created and exploited.

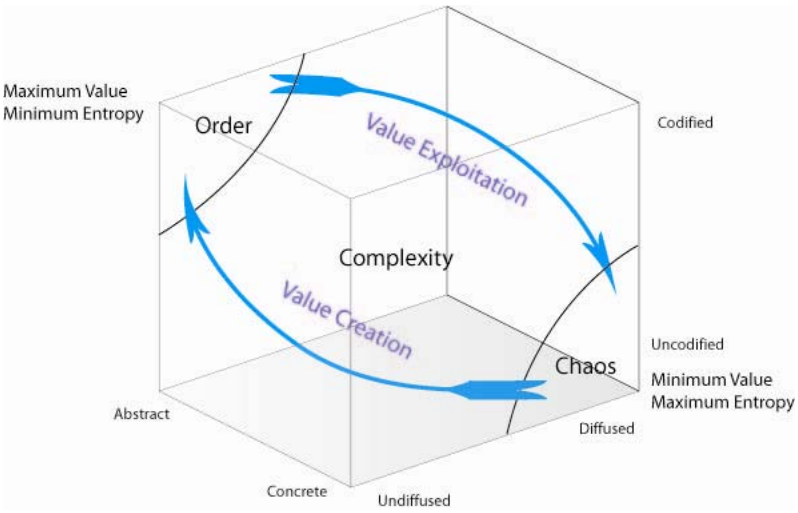

Figure 6 Boisot's I-space

The account above of a knowledge asset lifecycle has sacrificed variation in the interests of simplicity. The transition from concrete to abstract expression demands a considerable cognitive commitment from an agent community. Much depends on the repository of knowledge available to the agent community and the adopted forms of expression (one might reflect here of the advantages of a systemic modelling notation). Moreover, a knowledge asset may fail to be promulgated effectively through agent communities; associated ontologies may result in absorption, modification or rejection of a knowledge asset. Finally, change and the ensuing entropy may prematurely deprive a knowledge asset of any value.

Rather than navigate a fully realised trajectory through the I-space; the knowledge lifecycle may be defined by truncation, deflection, reversal or preservation.

Preservation of the knowledge lifecycle forms the focus for the next section.

6 The extended knowledge lifecycle

Valuable knowledge assets are notoriously difficult to formulate and suffer a precarious existence. The challenge therefore is to preserve valuable knowledge for extended exploitation; or rather, not to abandon knowledge prematurely.

Knowledge expressed through the application of a modelling notation enjoys greater robustness; a quality enhancing knowledge creation and exploitation while also achieving more effective dissemination. Robustness may also offer opportunities for longevity of knowledge value by identifying opportunities for adaptation in the zone of complexity, thus providing new trajectories of knowledge creation and exploitation. Moreover, robustness offers some protection in the zone of chaos by 'bounding' chaos and thus limiting the extent to which it can erode the value of knowledge. Where chaos is so bounded, value may be preserved in some robust fragment of knowledge and be available for the development of a new ontology (Boisot and Canals, 2004).

7 Agility – a reprise

The enquiry presented in this paper is predicated on the claim that agility provides a sustainable response to an absence of strategic certainty. Quite simply, ability is the capacity to sense and respond to change (and the ensuing entropy). In the first instance, agility depends on the perceptual powers of an agent to recognise signs of impending change, a key issue here is the fragmentary, partial and transitory nature of perception. Thereafter, the response to

change depends on the conceptual acuity of the agent to make sense of the impending change and devise a response. Even for the expert agent, this can be a challenging responsibility. To respond to the challenge, the agent relies on a vibrant repository of both tacit and explicit knowledge to comprehend the change and devise a response; in effect, to create a new tranche of knowledge assets. Moreover, the agent may be mandated to formulate the knowledge asset(s) such that value is preserved.

The creation of knowledge alone is insufficient; attention must be paid also to the content, formulation and expression of knowledge. One may reflect that agility depends on the adoption of a systemic modelling notation to verify, construct, revise and discard knowledge. Moreover, one might speculate further that the semantics of a systemic modelling notation factor agility into the formulation of knowledge and its ultimate deployment in the activities and structure of an agent community.

8 Conclusion

Few certainties have survived our postmodern world, and strategic certainty is not one of them. Agility is proposed here as a sustainable response to uncertainty. But agility depends on the creation and exploitation of knowledge in environments prone to unpredictable and volatile change. Much here depends on the formulation of knowledge and its influence on an enterprise. While corporate knowledge may be drained eventually of all value, few would want to discard knowledge prematurely without good reason. Care must be taken therefore to select a systemic modelling notation that imposes robustness of expression while preserving essential agility and responsiveness to change.

This mandate provides focus for the next paper on Agility.

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