

In Pursuit of Complexity

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Abstract

The pursuit of complexity is not quite the paradox it seems. The ‘command and control’ ethos that dominated the middle decades of the twentieth century created the (some might argue delusory) impression that management and organisation required little more than a few simple prescriptions. Since the late twentieth century, the combinatorial impact of (de)regulation, litigation, competition, speculation, corruption, crime, globalisation, climate change, conflict, terrorism, fashion, fad and (of course) innovation has contrived to dispel any illusion of simplicity. The corporate environment is characterised now by unprecedented turbulence, complexity and uncertainty. Business cycles informing the conduct of commerce and industry are less stable. Familiar assumptions of linearity and continuity are undermined by increasing and accelerating volatility. Conventional management theory struggles to provide sustainable strategies for survival, let alone success. And yet corporations do survive and even prosper. Many such corporations offer the nurturing and exploitation of intellectual capital as the key to survival. For the intellectual capital of an organisation to be effective, it must remain relevant and responsive to shifts (however subtle) in the interactions between an organisation and its environment. These corporations are learning to adapt to a complex environment that frequently is counter-intuitive, contradictory and paradoxical. The dynamics of knowledge creation provides an essential insight to understanding how organisations learn to embrace complexity.

1. Introduction

Flood concludes *Rethinking The Fifth Discipline: Learning within the Unknowable* (in humble reflection) with the claim that “really we don’t know very much about anything and actually never will”, (Flood, 1999). This apparently rather startling assertion is the result of applying complexity theory to ‘management and organisation’. Complexity theory offers many challenging and paradoxical ‘insights’ with which to interpret and direct the conduct of corporate activity.

Complex organisations are considered in terms of the interrelatedness of events and spontaneous self-organisation in response to feedback from events leading to emergence and new order. Also, within a complex organisation, only that which is local (in time and space) is knowable; that which is remote is unknowable. Finally, organisational knowledge inhabits a spectrum between mystery and mastery; navigating this spectrum means ‘learning one’s way into the future’.

Flood describes an environment that is both alien and forbidding, and yet surely resonates with much of the uncertainty pervading corporate activity. This paper commences by exploring the nature of complexity and how it applies to ‘management and organisation’. Attention is then turned to conventional and more recent management theories to evaluate their attempts to address both uncertainty and the more profound area of complexity. A similar assessment is applied to systemic reasoning which (arguably) is better placed to confront the challenges of complexity. Knowledge management builds on the foundations provided by systemic thinking and proposes a paradigmatic foundation for learning to sense and respond to complex shifts in the interaction between an organisation

and its environment. The intellectual capital of an organisation can be thought of as a repository of dynamically interrelated knowledge assets informing the response to complexity. A brief discourse is provided on key aspects of the knowledge creation cycle and the cognitive barriers that impede the creation, maturation and disposal of knowledge assets.

Inadequate forms of expression impede the elicitation of knowledge assets. System modelling techniques are now available that present a diversity of abstractions and perspectives with which to elicit, express, validate and connect a knowledge asset. This indicates how modelling tools and techniques can be exploited to diminish the impact of cognitive barriers and enable the development and deployment of knowledge assets to respond more effectively to the challenges presented by complexity.

The material presented in this report replies to Flood's proclamation; i.e. with all due modesty, 'we know more than we can say' (Polanyi, 1958) and we can know still more.

2. A brief discourse on complexity

2.1 Why organisations are complex

As with many other disciplines, management theorists are seeking to absorb the principles of chaos and complexity. Awareness has existed for some time that the competitive landscape is characterised by periods of tranquillity punctuated by discontinuous episodes of turbulence and upheaval (Tushman, Newman, Romanelli, 1986). Ormerod detects a similar phenomenon when investigating patterns of unemployment (Ormerod, 1994). Attempts are made to explain comparable behaviour in the financial markets (Cohen, 1997; Mandelbrot, 1998). All such conjecture leads, inevitably, to a discussion of chaos theory. In particular, Stacey (1993) seeks to explain patterns of organisational behaviour by drawing heavily on Gleick's account of chaos theory (Gleick, 1988)

Within this paradigm, the stabilising equilibrium of negative feedback loops and the explosively destabilising equilibrium of positive feedback loops constitute the attractors to which an organisation must respond. To be disproportionately influenced by either attractor invites collapse; sustainable survival depends on resolving the tensions between these two attractors. A strategy must be devised to enable navigation of a trajectory between the dynamic borders of these attractors; however, this is to enter an unpredictable universe that is neither stable nor unstable but a paradoxical combination of both (Kets de Vries, 1980; Quinn & Cameron, 1988; Hampden-Turner, 1990).

The application of complexity theory is concerned with an examination of the conditions under which an organisation must devise a survival strategy by adapting to the competing influences of order and disorder. The possible necessity for a duality of purpose may be traced back to the work of Burns and Stalker who noted the distinction between the mechanistic and organic organisations (Burns & Stalker, 1961); the former were bureaucratic, unitary and more suited to stable environments, while the latter were

flexible, pluralistic and more appropriate to volatile conditions. The increasing frequency and intensity of turbulence suggests that organisations may no longer opt for a unitary or pluralistic paradigm but, in accordance with Burns and Stalker, must strike a dynamic balance between the competing configurations.

Dominant interpretations of organisational life assume implicitly that success is achieved by restoring an organisation to stable equilibrium once there has been an environmental disturbance (Mintzberg & Waters, 1985; Senge, 1990; Ansoff & McDonnell, 1990). Stacey draws on complexity theory (Prigogine & Stengers, 1984; Waldrop, M 1992; Gell-Mann, 1994) to argue that such an aspiration impedes adaptability. Rather organisations must be thought of as complex adaptive systems collaborating to achieve some purpose (Mueller, 1986; Charan, 1991; Nohria & Eccles, 1992).

2.2 Modes of organisational behaviour

The application of complexity theory to the conduct of corporate endeavour suggests three models of organisation behaviour: ordered, complex and chaotic. Environmental turbulence influences significantly the mode(s) available to an organisation. Survival depends upon sensing turbulence and devising a response involving some reconfiguration of organisation behaviour.

The modes of organisational behaviour are illustrated in Figure 1. This simple schema invites a variety of profound interpretations, though while not inconsistent, emphasise different behavioural imperatives for an organisation.

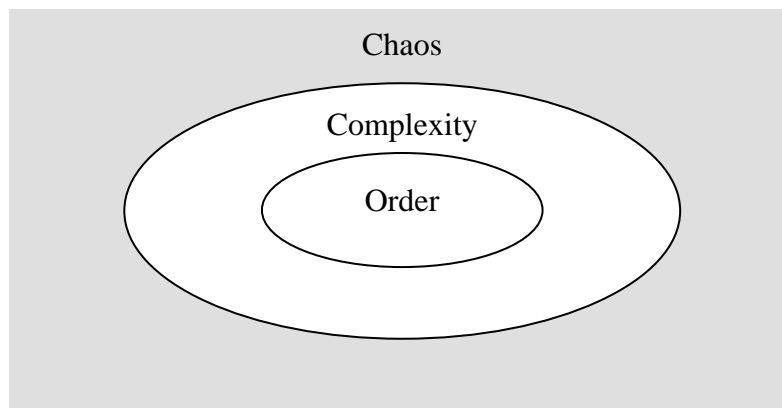


Figure 1. The modes of organisational behaviour

2.2.1 The 'ordered' behavioural mode

The 'ordered' mode implies stable behaviour. At first sight a stable organisation might be considered to represent the pinnacle of corporate achievement. For Battram (1996), however, a stable organisation is exposed to considerable threat; in particular, a stable organisation is vulnerable to operational stagnation and ultimate extinction.

A stable organisation responds to change by oscillating between a limited set of repeating stereotypical patterns of culture, structure and operations. Thus familiar paradigms are returned to again and again. Responses to change are always compromised by the imperative to restore stability and equilibrium; Battram characterises these organisations as ‘unresponsive and complacent’ and ‘not adapting, not responding to change’. Stable equilibrium is pursued with a determinism based on convenient assumptions of linearity, continuity and predictability.

Within the context of organisational behaviour, entropy may be defined as a measure of the disorder or randomness in a system. Market forces ensure that any prescription for success will be copied and in all likelihood improved upon. Entropy is introduced to a previously stable system. Boisot (1998) argues that the value contained in the ‘scarcity and utility’ of the successful prescription is exposed to the ravages of entropy and the odyssey to the ‘chaotic’ behavioural mode is underway.

2.2.2 The ‘chaotic’ behavioural mode

Chaos is concerned with the suspension of linearity and continuity; a phenomenon recognised as early as 1908 by Poincaré’s legendary proposition in the scientific article *Science and Method* that ‘a very small cause, which escapes us, determines a considerable effect which we cannot ignore, and then we say that this effect is due to chance’. Stacey (1993) provides the definition of an ‘inherently random pattern of behaviour generated by fixed inputs into deterministic rules, taking the form of nonlinear feedback loops’. He continues that while the behaviour may be unpredictable in the long term, it has a fractal pattern of self-similarity, and concludes that chaos is therefore ‘order within disorder’.

The nature of feedback loops determine whether an organisation is attracted to ‘ordered’ or ‘chaotic’ behaviour. Negative feedback exerts a dampening influence that tends to endorse strategic conventions and ease an organisation towards the ‘ordered’ realm. In contrast, positive feedback loops have an amplifying influence that generate an exaggerated response, and drive the organisation towards the ‘chaotic’ realm in a state of unstable equilibrium. Environmental signals may be weak and, if left unattended, can result in escalating consequences that are unexpected, unintended and counter-intuitive. When confronted with escalating consequences of positive feedback, an organisation may be attracted towards self-reinforcing spirals of behaviour (the successful prescription) that lead ultimately to excess and disintegration.

2.2.3 The ‘complex’ behavioural mode

Both ‘ordered’ and ‘chaotic’ modes of behaviour therefore invite failure. Complexity theory provides for the possibility of resolving the shifting tensions between negative and positive feedback loops as a sustainable survival strategy. To navigate this trajectory, an organisation is neither stable nor unstable, but a paradoxical combination of both (Quinn & Cameron, 1988, Hampden-Turner, 1990); i.e. the organisation adopts a complex mode of behaviour.

To exhibit complex behaviour (and therefore survive) an organisation must pursue a trajectory that it enables it to navigate a route between the fluctuating and competing attractors of stability and instability. To adopt Stacey's metaphor, an organisation must maintain a state of 'bounded instability' that is at the 'edge of chaos' far from stability and instability (Stacey, 1993). In more prosaic terms, an organisation must survey its environment to detect events and interpret signals emitted from those events. If signals indicate a shift (however subtle) in the essential behaviour of either the organisation or its environment, a judgment must be made as to whether the organisation should adapt to the shift by implementing some appropriate response.

3. Systemic thinking

3.1 The decline of the management orthodoxy

Conventional management wisdom is enshrined in the theories of convergence (Peters and Waterman, 1982), congruence (Porter, 1980 & 1985), contingency (Child, 1984) and configuration (Miller, 1986, Waterman, Peters and Phillips, 1980). Each subscribes to the concept of strategic planning, or rather to the unitary approach to strategic planning; i.e. strategic edicts grounded disproportionately in the ideology, culture and structure of the organisation. Mintzberg (1994) suggests that the unitary approach neglects the formulation of emergent strategy: a strategy that is realised but not expressly intended. Emergent strategy occurs where a set of actions become consolidated over time in response to some environmental signal neglected by the unitary strategy. The implication is that the assumption of predetermination that informs the strategic planning process is a fallacy. Rather, Mintzberg supports the view that strategy formulation is a dynamic process reflecting the shifting interaction between an organisation and its environment (Quinn, 1980; Pascale, 1984; Mintzberg and McHugh, 1985).

Conventional strategic planning espouses a formalised, deterministic approach that focuses on regular environmental signals but neglects weak and discontinuous signals emerging from a reality that is messy, ill-structured and volatile. Unfortunately, it is these very weak and discontinuous signals that often presage the greatest opportunities and threats.

Mintzberg is, in fact, arguing for a pluralistic approach to strategic planning where creative thinking is encouraged rather than thwarted. In this context, pluralism enables the formulation of emergent strategies by promoting intuitive thinking. Reliance on analytic thinking restricts strategic planning to a reductive speculation. Intuition is viewed as a higher form of synthesis utilising soft, speculative information that necessarily remains tacit unless elicitation is encouraged vigorously.

Strategic planning cannot rely on a unitary approach based on assumptions of predetermination, detachment and formalism. The reality is that strategic planning demands a pluralistic approach to a dynamic, ambiguous, discontinuous and interactive process exploiting both analysis and intuition. According to Drucker (1993), to realise this capability, an enterprise must become a learning organisation. A capability predicated on systemic thinking (Senge, 1990)

3.2 Systems theory – a reprise

Flood (1999) provides a coherent account of systems theory development and the more specific systemic thinking paradigm.

The origins of systems theory are encapsulated in the work of Ludwig von Bertalanffy (1968). As early as the 1920s, Bertalanffy recognised the distinction between closed and open systems theory, and proceeded then to develop a general system theory in the 1940s and 1950s.

Closed systems theory applies reductionist analysis to examine system components as independent entities. In contrast, open systems theory offers functional and relational analysis to examine system components within the interaction between a component and its environment. The general systems theory recognises that discrete systems can exhibit isomorphic concepts, laws and models, and thus knowledge from one system can be transferred to another system. Bertalanffy recognises also the ability of human beings to deploy symbols to represent concepts and values. These theories resonate throughout the ‘management and organisational’ canon.

Flood next turns his attention to Stafford Beer and the science of cybernetics (1959, 1966, and 1968). For Beer the three properties of a cybernetic system are complexity, probabilistic behaviour and self-regulation. Cybernetic systems are governed by feedback and control to achieve some specific purpose. Modelling informs cybernetic reasoning and evaluation, with management and operational models of ‘how the system really works’ developed and assessed so that one may illuminate the other. A basic tenet of cybernetics is the importance of information as a tool to control the effective and efficient operation of an organisation; a theme that echoes much ‘management and operational’ theory.

Flood identifies three treads to the Soft Systems Programme emerging from Checkland’s research (1981, 1990 with Scholes, and 1998 with Holwell): action research, interpretive-based systemic theory and the soft-systems methodology (SSM).

Action research is derived from the work of Kurt Lewin (1947). An action is executed and reflected upon to yield a deeper appreciation. Resulting suggestions are applied to the current action and invoke another reflection-action cycle. As this collaborative process of critical enquiry develops, knowledge is increased about the context, structure and behaviour of the domain.

Interpretive-based systemic learning urges a cultural study of any system in addition to the interpretations and perceptions that individual participants in the system may form with the cultural context.

SSM provides a set of principles for ill-defined problems based on a framework of thought, methodology and action. In broad terms, an unstructured real-world problem is identified and some loose consensus is derived on the nature of the problem. Systemic

thinking is then applied to the problem domain to elicit root definitions and generate conceptual models. The product of this analysis is applied to the real-world problem to determine desirability and feasibility before any eventual accommodation. The main feature of SSM is that it is virtually free of prescription; there is no start or end point, and SSM can be configured freely to address the priorities of the real-world problem.

3.3 The learning organisation

Peter Senge draws on the fundamental principles of systems theory to forge his definition of the learning organisation. Working with collaborators, Senge's *Fifth Discipline* (1990, 1994, and 1999) establishes a foundation from which organisational learning achieves primacy as a means to interpret, inform and implement corporate behaviour.

The five disciplines are: personal mastery, mental models, shared vision, team learning and (the fifth) systemic thinking. Personal mastery empowers individuals to develop and extend a personal vision while reconciling intrinsic aspirations. Mental models provide a network of cognitive processes to recognise and contextualise organisational environment. Shared vision refers to a common sense of purpose and commitment from which to forge focus and energy for organisational learning. Flood notes here that learning refers to generative rather than adaptive learning. Team learning seeks to align cognitive endeavour and thus create a synergistic environment where the team exploits fully the individual contribution of each team member. For Senge, systemic thinking achieves primacy by integrating all five disciplines and 'delivers the empowering potential of the learning organisation' (Flood, 1999). Systemic thinking addresses both detail and dynamic complexity to adopt a holistic stance and thus explain organisational behaviour in terms of systems dynamics, where system archetypes are used to explain the underlying structure in behaviour.

The explication of mental models is an essential precursor to the more advanced level of organisational learning represented by systems thinking. In addition to endorsing much familiar material on systems thinking, Senge identifies two crucial contributions (Senge, 1994):

- systems thinking requires a qualitative shift from the more familiar linear thinking, i.e. organisations are considered to be constellations of processes and not structures (Capra et al, 1991)
- self-organising systems ('where order emerges from chaos') provide a prototype for managing organisations in turbulent environments (Wheatley, 1993).

The adoption by Senge of Wheatley's conclusion (and by implication those of Stacey) that self-organising systems provide a template for understanding organisational behaviour indicates that this concept is now gaining acceptance in the literature. However, besides including a reference to the concept of self-organising systems, there is little comment on how this may be factored into the theory of organisational learning. Certainly techniques for resolving the tensions arising from stable and unstable attractors are neglected.

Nonetheless, from these foundations, Kemeny et al consider effective systems thinking (and thus organisational learning) to be based on simultaneous reflection on: events, patterns of behaviour, systems, and mental models (Kemeny et al, 1994). Goodman and Kemeny advocate the use of archetypes as a mechanism for constructing credible and consistent hypotheses for comprehending systems and the associated mental models devised by domain experts (Goodman & Kemeny, 1994). An archetype is defined 'as nothing more than a mental model made visible' and may be used to redesign systems by introducing and removing nodes, and adding loops and breaking links between the nodes. When an organisation 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 the assumptions underlying organisational behaviour, culture and beliefs
- performing scenario planning to evaluate assumptions about the future
- developing a personal vision and learning to see the world from a creative and interdependent perspective, and not merely from a reactive viewpoint.

Much of Senge's approach to organisational learning is concerned with defining organisational circumstances and attitudes that are conducive to enabling the domain expert to articulate the knowledge, assumptions and beliefs populating the mental models that reflect some perspective of an organisation. Again, the inescapable conclusion is that to create the sympathetic circumstances necessary for organisational learning, much sustained and reinforced effort is required to overcome entrenched organisational defence routines. It may also be concluded from Senge's study that, for all their flaws, mental models provide a fertile source of knowledge that may be penetrated through the use of archetypes. The concept of knowledge penetration is possibly mistaken. 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.

4. Knowledge creation paradigms

4.1 The primacy of tacit knowledge

From this brief survey of organisational learning, there can be little dispute that the mental models devised by individuals and small groups of domain experts provide two potent sources of knowledge:

- where a system is sufficiently complex and variable to defy attempts at logical deduction, mental models are used to develop an unconscious understanding of the system

- mental models are used to detect shifts in patterns of behaviour that may presage a competitive opportunity or threat.

It is also clear that knowledge embedded in the deepest recesses of mental models is occasionally capable of ascending through decreasing levels of obscurity until it becomes possible to articulate the knowledge in some form that is meaningful to the organisation. Once this knowledge emerges, it becomes available for integration with knowledge held in the public domain and for exploitation by the organisation. However, organisational learning is not simply a matter of explicating knowledge held in mental models. There is also the complementary process of disturbances in the public domain generating the material necessary to stimulate unconscious cognitive activity and the consequent evolution of new mental models.

4.2 Nonaka and Takeuchi's Knowledge-Creating Company

Nonaka and Takeuchi argue that organisational learning follows a cyclical trajectory (see Figure 3.5) where knowledge may be created in either an explicit or tacit state and may be transformed between those states (Nonaka & Takeuchi, 1995).

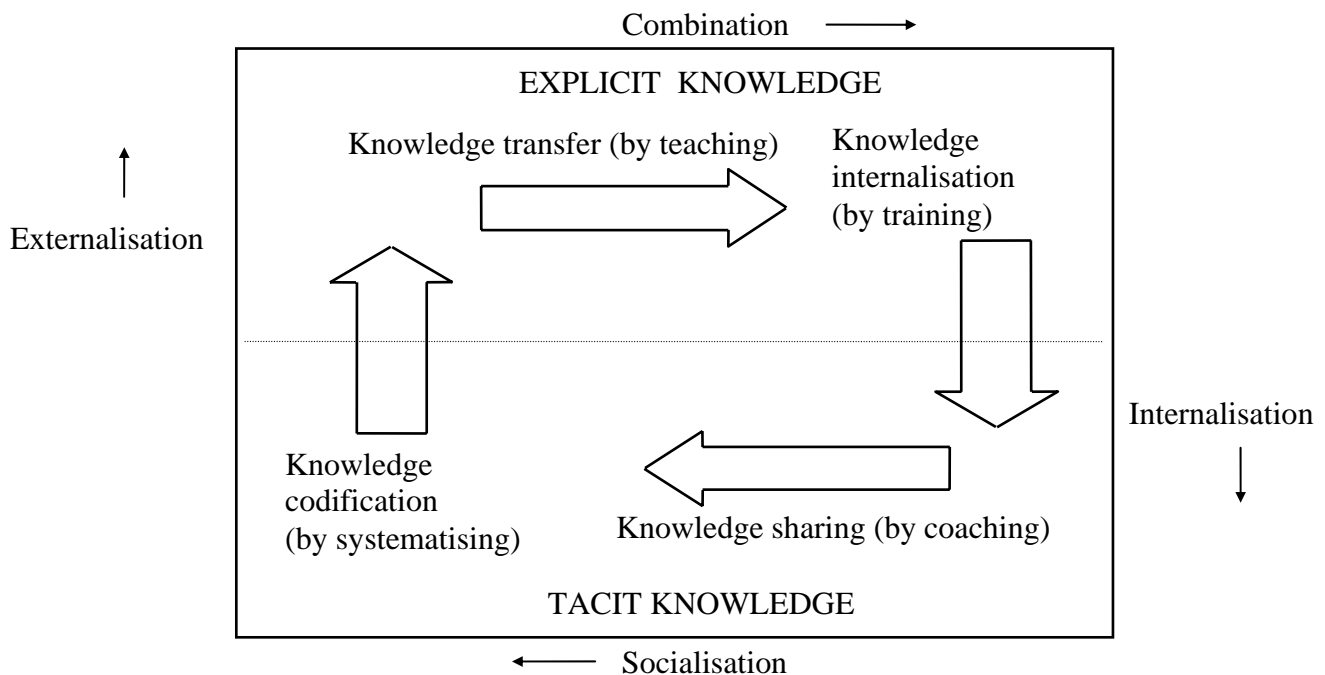


Figure 2. The knowledge creation process (Nonaka and Takeuchi, 1995)

Nonaka and Takeuchi borrow the terms explicit and tacit knowledge from Polanyi to distinguish between knowledge that is codified and thus transmittable in some systematic language, and knowledge that is personal, context-specific and thus difficult to formalise and communicate (Polanyi, 1966). Polanyi's argument on the importance of tacit knowledge in human cognition is that knowledge is acquired by actively creating and

organising individual experiences. Moreover, explicit knowledge represents ‘only the tip of the iceberg of the entire body of knowledge’.

Nonaka and Takeuchi distinguish between the learning organisation and knowledge-creating company. They claim learning organisation theory is predicated on an assumption of ‘rightness’ and the necessity for intervention from some internal agency. In reality, they assert that organisations create new knowledge continuously by reconstructing existing behaviour, perspectives, culture and beliefs. Moreover, a broad criticism of literature addressing organisational learning is the absence of any guidance on how to actually create knowledge; by rectifying this deficiency, Nonaka and Takeuchi claim to establish the difference between a knowledge-creating company and a learning organisation.

For the knowledge-creating organisation, knowledge is believed to be created through the conversion and mobilisation of tacit knowledge within ontological and epistemological framework. The ontological dimension describes the levels of knowledge diffusion throughout an organisation, while the epistemological dimension defines the distinction between explicit and tacit knowledge.

As Nonaka and Takeuchi point out, the socialisation and combination processes simply disseminate knowledge without any change of state and therefore exert only limited influence on the extension of an organisation’s knowledge resource; although this is not to discount the importance of diffusion. However, to identify opportunities for the innovative creation of new knowledge, it is necessary to explore the processes of externalisation and internalisation where, hopefully, a vibrant interaction between tacit and explicit knowledge might be detected. They argue that to achieve this vibrancy, knowledge must be in broad alignment with the strategic intention although this does not necessarily prohibit the reconstruction of inherent perspectives or cognitive frameworks. Secondly, organisational knowledge may transcend the immediate and obvious needs of the business. Finally, the texture of the knowledge should, in some respect, reflect the complexity and uncertainty of the interrelationship between the organisation and its environment.

4.3 Boisot’s epistemological space (E-Space)

In an attempt to explain how knowledge is created and disseminated throughout an organisation, Boisot explores a variety of theoretical perspectives based on the structure and communication of information (Boisot, 1995). The exploration commences with the proposition that cognitive activity employs two fundamental techniques to extract information from data: coding and abstraction. Coding is defined as organising an experience of some environmental phenomenon into a perceptual category selected from a repertoire of possibilities exhibiting varying degrees of efficiency with respect to that experience. Abstraction enables the individual to generate concepts allowing the perceptual categories to be managed more efficiently by creating generalisations enabling discrete perceptual and conceptual categories to be manipulated as single entities.

Accordingly, Boisot declares that coding economises on the quantity of data to be processed, while abstraction economises on the number of categories through which data will have to be processed. It is argued that efforts towards greater abstraction share a common motivation with attempts at greater codification: they both constitute an endeavour to economise on the data defining a domain and the effort required to process that data. However, it should also be noted, that Holton argues in favour of uncoded abstract knowledge providing a “well-spring” of scientific creativity’ (Holton, 1986). Moreover, Holton contends that speculation can be guided by themata that are ‘universally shared even though scarcely articulated’. Abstraction and codification conventions thus represent a strategy for introducing simplifying assumptions and configurations that better equip the domain expert to confront a deluge of complexity and uncertainty that might otherwise be overwhelming. Successful abstraction and codification conventions must therefore achieve some balance between capturing the essence of a domain while necessarily sacrificing some of its detail. Although abstraction and codification conventions share a common motivation, their individual strategies are different yet complementary. Boisot reasons that codification strategies strive to economise on processing data by reducing the complexity of form, whereas abstraction conventions seek greater economies by reducing the complexity of content. Codification thus proceeds by differentiation to enumerate finite sets of discrete elements, while abstraction proceeds by integration to cluster these elements into discrete correlations between individual phenomena.

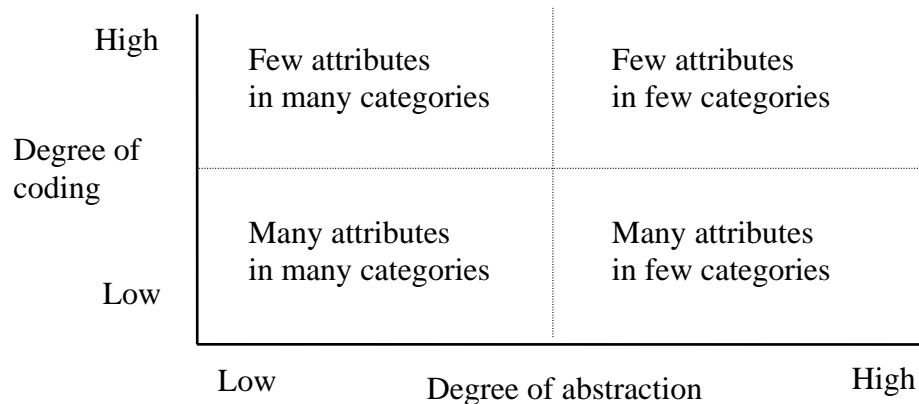


Figure 3. The coding and abstraction schema (Boisot, 1995)

With this schema, Boisot had transformed Nonaka and Takeuchi’s epistemological dimension into a two-dimension space, providing a penetrating insight with which to explore further the relationship between tacit and explicit knowledge.

Entropy attacks the utility and scarcity of knowledge and, in so doing, undermines the prevailing abstraction and codification conventions, i.e. entropy drags knowledge into the zone of many attributes and categories. A sustained cognitive investment is required to restore knowledge utility and scarcity by moving towards a more ordered region where knowledge assets are expressed with fewer attributes and categories, i.e. effective abstraction and codification conventions are brought to bear on the knowledge reservoir.

Boisot's schema is derived from Polanyi's description of the 'different models of knowing' (see Figure 4). The concrete and uncodified knowledge domain is available to the largest constituency, but deals only with unstructured knowledge and applies only to 'local' phenomena. The semi-tacit knowledge domain comprises the creation of knowledge assets derived from a willingness to invest in the acquisition of codes and categories providing a cognitive framework to elicit tacit knowledge. The domain of abstract and codified knowledge represents the apex of cognitive activity; within this domain: novelty, invention, innovation and discovery are all possible.

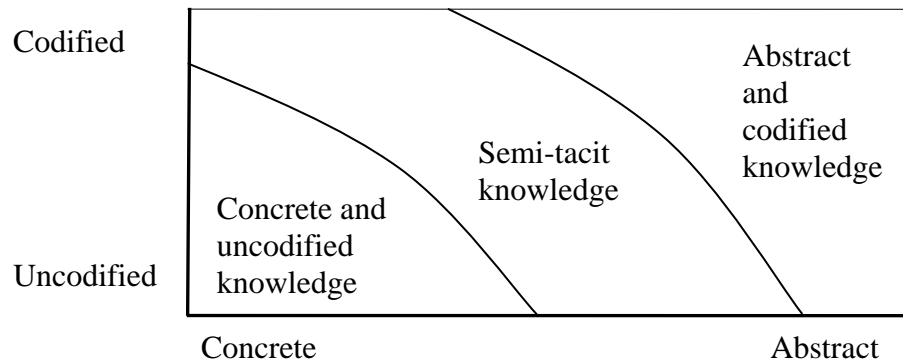


Figure 4. Polanyi's different modes of knowing (1958)

Boisot (1998) provides yet another interpretation of the E-space (Figure 5) that superimposes the zones of order, complexity and chaos. The zone of chaos is where entropy is at a maximum, while the knowledge is exposed to minimum entropy in the zone of order. Maximum entropy diminishes the utility and scarcity of knowledge, and creates the circumstances necessary to launch a knowledge creation cycle. To embark on this cycle, access is required to both the tacit and explicit knowledge available to domain experts; indeed, it is the tacit knowledge frequently that offers most opportunity. The knowledge creation cycle embarks on a value-generating trajectory towards the zone of order, i.e. the region of minimum entropy. It is in this region, where new knowledge assets can be expressed with mature abstraction and codification conventions, have optimal utility and scarcity, and are of greatest potential value. Exploitation of knowledge assets reduces their utility and scarcity immediately, thus increasing entropy and drawing them towards the zone of chaos and ultimate abandonment. It is in the zone of complexity that the knowledge asset is available primarily for exploitation. This very simplified explanation of the knowledge creation process describes the lifecycle of a knowledge asset. Boisot argues, however, that an organisation must learn to exist in and traverse all three zones.

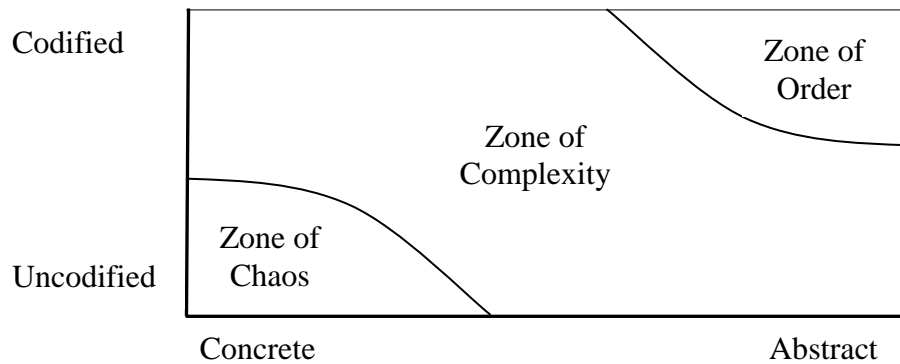


Figure 5. Ordered, Complex and Chaotic zones in E-space

5. Modelling complexity

Narration (both verbal and written) is a notoriously unreliable mode of expression. Domain experts probably can describe what is local with some degree of coherence and precision; those domains remote to the expert are quite another matter. Complexity demands scrutiny of both these domains. Mature abstraction and codification conventions provide the foundation for eliciting tacit knowledge resident in both local and remote domains, thus extending the reservoir of explicit knowledge and enabling the adaptation of corporate direction.

Abstraction and codification conventions find expression in models of domains. Models perform a quite specific role in capturing the essence of a domain without sacrificing too much of the detail; i.e. distinguishing between the essential and superfluous, to achieve some intelligent balance between genericity and specificity. Of particular pertinence to management and organisation are models that represent and connect strategy, behaviour and structure. The integrity of abstraction and codification conventions are preserved by the semantics used to develop models. Furthermore, models support both holistic and reductionist scrutiny of a domain (another key feature of domain reasoning). Crucially, models also may be exploited to scrutinise a domain from a variety of perspectives yielding a variety of diverse semantic interpretations.

Finally, a variety of tools support automation of the modelling process; some of which support the configuration of methodological extensions to address the individual complexities of specific domains. Moreover, many tools enforce semantic integrity and offer diagnostic support

Modelling complexity will be the subject of a subsequent paper.

6. Conclusion - Learning to Sense and Respond

Boisot asserts that organisations must learn to exist in the zones of chaos, complexity and order. Entropy renders residence the chaotic region untenable and the ordered zone unsustainable in the longer term. Corporate survival depends therefore on an organisation exhibiting complex behaviour; i.e. achieving a dynamic and paradoxical equilibrium between the competing and fluctuating influences of order and chaos. Survival demands that organisations must behave as complex adaptive systems, where knowledge may be generated and exploited to provide a charter for corporate survival and prosperity.

Complex adaptive systems survive by learning about their environment. Learning involves developing the skills (or instincts) to sense (or anticipate) systemic perturbation and devising some strategy for response. Moreover, non-linearity and discontinuity requires that not just learning, but the learning strategy also, must be adaptable.

Business Models are an extremely effective device for locating perturbation, and devising, evaluating and implementing a response, i.e. learning to sense and respond. In contradiction of Flood, therefore, models reveal knowledge and provide an enabling framework for refreshing the corporate knowledge pool.

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