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Complexity Theory as a Practical Management Tool: A Critical Evaluation

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Complexity theory is receiving increasing attention in both academic and popular literature as a potential management tool. As momentum gathers surrounding its popularity in practical management, complexity theory is poised to become a management 'fad', and potentially an influential paradigm for the future. However, much of the literature concerning complexity theory contains inconsistent terminology and a lack of operationally empirical definitions. This has made it difficult for researchers to specify empirical questions in order to frame complexity research, and for practitioners to acquire the key principles for implementation. It has also opened a Pandora's Box of commentaries which proclaim that complexity theory is a new management panacea. This paper provides a critical account of the utility of complexity theory as a management tool, and concludes that while a number of metaphors and principles might suggest useful ways of thinking about management, the concept is neither new nor a panacea, and practitioners are urged toward caution.

Periodically, the science and practice of management is the beneficiary of a new way of thinking or a new set of practices designed to improve productivity, efficiency, profitability, quality or some other key element of organizational performance. Claims for 'new' approaches or theories are not uncommon, but the reality is that few gain even 'fad' status, and fewer still transform into genuine theories or methods that gain momentum in practice on a wide scale. Those approaches that do achieve some popularity still take time to convert pivotal evangelists, win over practitioners and yield demonstrable results. Put simply, 'new' ideas take time to gain a critical momentum. Along the way, however, management ideas have a tendency to get distorted by confusing academic rhetoric, slick 'consultant-speak' and misleading gossip. Complexity theory is one such concept. However, its transition from the natural world to the world of management is still comparatively young and, although comparatively slow to gain widespread acceptance as a valid management perspective, it has increasingly attracted a number of followers despite remaining clouded in misunderstanding (Stacey, 1996). For converts, it is frequently lauded as the next management cure-all; as a radical, powerful new paradigm for business development (Lynch & Kordis, 1988). For others, however, the popularity of complexity theory as an organizational tool is guarded at best (Merry, 1995). They suggest that few examples exist of organizations which have directly benefited from a practical form of the theory. This paper seeks to take a more critical perspective toward complexity theory. It seeks to explain the philosophy, illuminate the common metaphors employed by writers in the field, assess its unique or new contribution to the understanding of organizations and management, consider its current applications, and ultimately, make a critical assessment of its status and utility as a practical managerial tool.

Although the conceptual basis of complexity theory arose from work undertaken in biology and physical systems science, and subsequently from systems theories that have developed from

organizational science, it is typically assumed that its popularity amongst managers has improved as a consequence of environmental change. For example, Cohen (1999), writing in the preface to the special issue on complexity in the journal Organization Science, noted that current trends, including dramatic changes in the structure and operation of business, government and non-profits, have increased managers' attraction to the ideas of complexity theory. In short, the world and, by association, organizations are in a state of transformative change that has heightened their immersion in uncertainty. Managers and scholars have always sought theories to help deal with the dynamism of organizations (Goldberg & Markoczy, 2000), and complexity theory fills this need.

Similarly, Tetenbaum (1998) identifies seven trends that help explain why complexity theory has fallen on fertile ground: technology, globalization, competition, change, speed, complexity and paradox. She wrote: "The new world is full of unintended consequences and counterintuitive outcomes. In such a world, the map to the future cannot be drawn in advance. We cannot know enough to set forth a meaningful vision or to plan productively" (1998: 24). Tetenbaum's lamentation about change and uncertainty is not a new call to action. Kelly (1994, 1998), writing a decade ago, argued that we need new ideas, paradigms and practices to make sense of the tumultuous changes that have come about through global restructuring of the economy, radical new technologies, and advances in social, political and cultural change.

In fact, history is replete with examples of ongoing proclamations about the need to think differently in order to face unprecedented change (Blainey, 2000; Roberts, 1995). Accordingly there has been no shortage of proposed management approaches. However, there is some consensus that the forces for change identified by Cohen (1999), Tetenbaum (1998), Kelly (1994, 1998) and many others (e.g. Kotter, 1990; Kanter, Strein & Jick, 1992; Huber & Glick, 1995; Armenakis, 1999), are more sweeping than any previously encountered in the last few centuries of theoretical management development. While the degree of uncertainly and transformation is perhaps exaggerated, it is real, and it is reasonable to conclude that managers are seeking practical ways of dealing with the complexity that change has incited in their organizations.

Complexity Thinking

According to Keene (2000), the conventional way of looking at organizations remains mired in the principles of scientific management, which emphasize control, order, predictability and the deterministic world of cause and effect. She contends that the mechanistic approach of reducing all systems to their constituent parts is inadequate to allow managers to deal with the changing environment. It also explains the constant stream of new business fads, of which complexity might be one. In other words, the need for non-reductionist ways of approaching management problems has set the scene for complexity theory to be considered.

Dent (1999) describes complexity science as "an approach to research, study, and perspective that makes the philosophical assumptions of the emerging worldview" (1999: 5). This worldview can be contrasted with the classical (scientific management) view, which assumes linear causality and encourages reductionist approaches to management. Complexity theory therefore

stresses acausal, holistic interpretations. In a similar vein, Marion and Bacon, (2000) describe complex systems as "robust, involving multiple, often redundant chains of interaction and causation…" (2000: 72). They specify three key characteristics of complex systems. Firstly, the whole is more than the sum of the parts, which means that reducing a system to its elements might not be helpful in understanding all of the phenomena it produces. Secondly, complex organizations stimulate outputs that cannot necessarily be predicted simply by understanding all of the inputs. This is because thirdly, complex organizations can create behavior that is neither definitively predictable nor unpredictable, a circumstance that has acquired the popular label of the 'edge of chaos' (Peters, 1992). Here, there is enough chaos to preclude all prediction, but also enough order to maintain functionality.

Of the three characteristics, few would disagree with the first or, indeed, the second. The third key characteristic suggested by Marion and Bacon would also have few detractors although a sophist might argue that rather than the result being 'neither definitively predictable nor unpredictable' it might be considered 'predictably unpredictable'.

One stream of research that has been pivotal in the development of complexity theory is the work of Nobel prize-winning Belgian physicist Ilya Prigogine and his colleagues, in the field of non-equilibrium thermodynamics (Prigogine & Stengers, 1984). Prigogine explained the existence of order in physical systems despite the fact that they should deteriorate in line with the second law of thermodynamics, which maintains that systems should always move toward disorder, a process known in physics as entropy. In other words, physical systems should theoretically break down over time. Essentially, work in non-equilibrium thermodynamics demonstrates that change, development and transformation occur in open systems which are far from equilibrium (MacIntosh & MacLean, 2001). On the surface this may seem distant from the practical realities of organizational life. However, researchers and managers have observed this phenomenon in organizations. One needs only to consider the "irrational exuberance" exhibited before the recent stock market crash to understand that rational beings working through a rational market can behave irrationally. Why then should companies which, being comprised of individuals, behave differently? Byeon (1999) employed the metaphor of non-equilibrium thermodynamics to explain self-organization in political systems. He reported that the political system under investigation moved toward increasing complexity, and also a higher degree of order.

Complexity theory has also been advanced by applications in biology where the search for an explanation to the apparently escalating evolutionary complexity of living organisms has been sought. This theoretical view is inconsistent with conventional evolutionary theory which maintains that biological evolution is random and neither encourages simplicity nor complexity. In particular, attention has been directed toward the adaptation of organisms as systems living close to the edge of chaos (Kaufmann, 1994, 1995).

Another stimulus to advance complexity theory in organizations has been contributed through work on systems theory in organization science. General systems theory proposes that the universe should be recognized as a vast, interconnected, and interdependent whole (Kielhofner, 1995), where a system refers to "any complex of elements which interact and together constitute a logical whole with a purpose or function" (1995: 9). Open systems allow the dynamic, self-

organization that is exhibited during interaction with the environment (Allport, 1968). An extension of this, dynamical systems theory, assumes that when sufficient energy is channeled into systems of complexity, new states of organization can emerge spontaneously, arising from chaotic states (Haken, 1987).

The 'Edge of Chaos'

As a result of the influence of thinking from physics, biology and systems theory, complexity theory has become associated with the idea of the 'edge of chaos.' Complexity and the 'edge of chaos' implies a new approach to organizational management, change and transformation. It demands an understanding that systems behave in a relatively stable manner until they reach a critical threshold, which represents the edge of chaos, or in more technical language, a bifurcation point. At this time, the system's mechanisms become stressed, it becomes unstable and out of equilibrium, which in turn opens it up to new 'energy' or input from the environment. This latter point is important because it explains how an organization can counter the natural forces of entropy, as described by the second law of thermodynamics. In simple terms, all systems should degenerate, or at least lose energy. This means that 'emergence', or self-organized, ordered activity should not occur, because it would mean that the system is generating something more than the sum of its parts, which conflicts with the laws of physics.

However, organizations are not physical systems, and when they reach the bifurcation point (edge of chaos) they start to gain energy and produce unexpected results. How this actually happens remains mysterious, primarily because organizations are made up of individuals and how the 'edge of chaos' concept relates to the individual psyche is unclear. Nevertheless, the available evidence suggests that individuals and groups find new energy to create and innovate when their organization is in this state (Tasaka, 1999). In addition, at this time, the system is susceptible to tiny changes which would have no impact if it were at equilibrium, but can lead to significant and unpredictable outcomes at disequilibrium.

Thus, we arrive at one of the troublesome aspects of complexity theory. Little is known about what happens at the human level in organizations that can 'surf" (Pascale, 1999) the edge of chaos. This surfing is considered an ideal for organizations because it encourages innovation and creativity without actually tipping into the 'black hole' of chaos itself; a little bit of chaos is good, but too much can be a disaster. Managers can be 'hands-off', allowing chaos to provide an environment suitable for stimulating innovation, while ensuring that there are sufficient systems and rules to avoid plunging headlong into complete chaos (Pascale, 1999). However, the somewhat nebulous achievement of being poised or surfing between chaos and equilibrium remains elusive (Pepper, 2002).

The problem is that at the 'edge of chaos' small variations in conditions can lead to not just unpredictable, but also unrepeatable outcomes. While new properties can emerge, it is difficult to ascertain exactly how a manager can facilitate more innovation when the principle insists that they remain hands-off. Tom Peters (1987, 1992) advocates that managers should move people from complacency toward the edge of chaos. But, of course, organizations dance around the edge of chaos all the time, sometimes close and other times distant.

The reality is that managers rarely remain hands-off. Brown and Eisenhardt (1998) in their research of major organizations suggest that competing on the edge is not an efficient or predictable way to do business. Yet they indicate that organizations who are successfully employing complexity theory have achieved results because they have found the edge between structure and chaos, but they imply that managers frequently maintain sufficient control to ensure the organization's focus is maintained. According to Brown and Eisenhardt, this may well require organizations to accept frequent changes to strategy.

Pascale, who coined the phrase, 'surfing the edge of chaos' (1999), remarked that organizational innovation occurs in the delicate balance between rigid structure and unbounded chaos (Pascale 1990). Delicate indeed, and on the face of it, difficult to prescribe to a novice manager. Perhaps, less so to the experienced manager, who is often more skeptical, recognising that aspects of new 'faddish' theories often contain a degree of truth within them and who might frequently consider himself or herself as working on the edge of chaos. Pascale (1999) makes some observations about the nature of complex systems that draw us closer to practical management implementation. First, complex systems are at risk when at equilibrium. Although it may be counter-intuitive, equilibrium and stability are precursors to failure. Secondly, complex systems exhibit the capacity to self-organize and show emergent properties, and therefore the edge of chaos is not actually chaotic. Thirdly, complex systems move toward the edge of chaos when confronted with a complex task. Finally, complex systems are living systems and cannot be directed, only disturbed. The role of managers is therefore not one of trying to take control by enforcing rules. Instead their efforts are best directed towards keeping the system in disequilibrium. Of course, this raises the issue of how this is to be undertaken on a practical basis. For example, are managers expected to remove organizational polices or rules when they perceive equilibrium approaching? How is equilibrium measured anyway? Does complexity theory imply that organizations are better off without managers altogether, because they only tend to encourage equilibrium? Brown and Eisenhardt (1998) have provided a number of answers to these questions. For example, they believe that managers are integral to the process and that these individuals understand that their primary challenge is in embracing change. To do so, however, requires that the manager maneuver through chaos and time and do so with confidence that they can adroitly avoid the rock of Scylla while remaining clear of the whirlpool of Charybdis. The problem with Brown and Eisenhardt is that they accept instability and uncertainty with too much certainty.

Chaos and Complexity: Complementary but not Interchangeable Concepts

Another issue arises from confusion concerning the relationship between the often interchangeably used terms chaos and complexity. Although it can be argued that complexity was born from chaos (Fitzgerald, 2001), chaos and complexity are perhaps best viewed as complementary notions, at least from a managerial perspective, because they both encourage thinking differently about the way systems and organizations operate. So far, we have been talking about complexity theory where emergent phenomena can arise from complex systems, and that these phenomena cannot fully be explained by the sum of a system's parts. Even from the apparently random, patterns can be identified (Kauffman, 1995). Weather is an oft-cited system that benefits from complexity thinking. It goes beyond a systems view, because it is a

complex system that is non-linear where the relationships between cause and effect are disproportionate and uncertain (Beeson & Davis, 2000). On the other hand, chaos theory applies when simple systems spit out complex phenomena; from order comes chaos. For example, when birds fly in flocks or fish swim together in shoals, their simple rules of behavior become exaggerated into apparently chaotic activity. From complex systems comes simple behavior and from simple systems comes chaotic behavior. We accept that the two terms represent the ends of the same conceptual continuum. Some might argue that complexity theory is simply the more general term for what started out being called chaos theory, and is what McElroy (2000) terms "the study of the pervasive innovation in the universe" (2000: 196). We certainly agree that the underlying principles found in nature apply to human organizations, but we would contend that in complexity, autonomous agents in the form of people and their relationships play an intrusive role that does not occur in nature. Indeed, while the underlying principles may be the same, there is little evidence to suggest that specific results found in nature are replicated in organizations. Surely, there is a difference between natural and social systems?

Directionality is troublesome when considering complexity and chaos in organizations. Are organizations actually made up of 'simple' units – humans – that interact and produce complexity? Should organizations be seen as inherently complex, essentially chaotic systems that periodically produce orderly patterns? In organizations, perhaps the interaction of many 'simple' humans can produce complex systems, which in turn can produce complex behaviors as well as occasionally some simple but unexpected, emergent behaviors. Perhaps the best way to think about these complications is to consider 'edge of chaos' circumstances as producing 'chaordic' outcomes, being chaotic and orderly at the same time (Fitzgerald & van Eijnatten, 2002).

Chaos and complexity really need to be considered in unison from an organizational perspective. For example, despite the simplicity of some organizational rules governing processes, they sometimes become chaotic. Conversely, the emergence of simple, but unexpected behaviors in complex organizations is also important to understand. Although technically incorrect, complexity and chaos are frequently employed with the assumption that they are interchangeable (Fitzgerald, 2001). Certainly from the organizational perspective it may be more useful to consider the concepts as complementary, rather than interchangeable.

However, whilst chaos and complexity may perform as complementary notions, complexity theory appears to function with greater utility when applied to the organizational setting. This is primarily because it provides a way of interpreting the behavior of a system where its individual components do not adequately predict the emergence of new properties. In other words, as a management tool, the capacity to stimulate unexpected innovation in the form of emergence is quite compelling. In the case of an organization, this means that some behaviors will occur unexpectedly. Changes may take place that were not solicited, expected or imagined previously, such as the emergence of an innovative product concept, or the spontaneous streamlining of procedures. Naturally, this is the greatest promise of complexity advocates; somewhere deep in the bowels of an organization, great opportunity for innovation and creativity stirs, ready to be pounced on by complexity aware managers and leaders. It is the property of emergence which arouses the greatest excitement because it means that organizations can deliver spontaneous and unpredictable solutions to problems through self-organization. The concept of emergence

functions as a descriptor of the patterns that are exhibited at the macro level of an organization, and that would otherwise remain inexplicable (Goldstein, 1999).

Complexity Theory & Change

One of the practical implications of emergence is that managers can, and should be, 'hands-off', because given the right preconditions, the system is capable of self-organization. However, a 'hands-off' approach is difficult for some managers and organizations because it is inconsistent with the dominant perception of how organizations achieve success, which revolves around the development of rules and processes (Dolan, Garcia & Auerbach, 2003). Part of the difficulty arises because traditional thinking views change as a transition from one equilibrium state to another, without the mess that accompanies change in practice (Pascale, 1999). This view may be weakening as organizations view flux and disequilibrium more as natural states. But it also has implications for the management of change because emergent behaviors are typically inadequately analyzed (Lissack, 1999) and deliberately introduced change processes are generally linear and rational.

It is perhaps because traditional models view change as a linear process that complexity theory has been deployed more recently to understand change that is neither linear nor rational. For example, complexity metaphors have been employed to explain successful entrepreneurship by explaining change and random events, helping to decipher the impact of 'luck' that comes about during disequilibrium and the general turmoil of entrepreneurial activities (Peterson & Meckler, 2001). Complexity can also serve as a metaphor for transformative change that goes beyond the conventional change metaphors that deal with biological evolution (Dubinskas, 1994) such as punctuated equilibriums (Brown & Eisenhardt, 1997), where change is infrequent but substantial, 'punctuating' long periods of relative stability. Furthermore, complexity notions help explain why change is often reported to be less linear than the rational processes that introduce it. For example, Redfern and Christian (2003), in a study examining change in nine health care centers, noted that in at least three centers change was dynamic and chaotic. They observed that change in health care organizations is more likely to be disorderly than rational. Similarly, Brown and Eisenhardt (1997) examined how organizations engage in continuous change and revealed that successful firms balance structure and chaos. This 'chaordic' approach was more effective than planning for, or reacting to, unforeseen changes. Styhre (2002), demonstrated that complexity theory can be a useful construct for understanding the change management process, which he noted is rarely as linear and systematic as conventional theory would have us believe. Furthermore, complexity theory suggests that changes are produced on the basis of a "multiplicity of interconnected causes and effects whose relationships are too complicated to conceive of from within an analytical framework assuming linearity" (2002: 349). In short, change is the norm not the exception (Salem, 2002).

We can also view organizational change as an emergent feature of a complex system. Beeson and Davis (2000) describe this as the state where the "behavior of the system as a whole is the complex and unpredictable product of multiple interactions and interventions by individual actors" (2000: 183). Change management as an action therefore becomes generalized to being an everyday activity for managers rather than something special or unusual. In this sense, every

action is one of emergence. At the individual level, no human is fully predictable and can contribute innovatively at any time without prompting. There are some implications for managers in embracing this assumption, as it returns to the necessity for a hands-off mentality, and a capacity to manage the relationship between control and freedom (Axerod, 1999).

The Application of Complexity Theory

Thus far, we have observed that complexity theory has gained momentum in management literature as a response to increasing turbulence in society and business. We have acknowledged that the concept is not new in that it has its genesis in physics, biology and well-established systems theories in organizational science, and that complexity theory is founded upon the cultivation of a chaordic or 'edge of chaos' situation, where novel and spontaneous activities can self-organize. Holbrook (2003) provides a useful summary of our exploration so far:

> *When such insights are applied to real-world systems - whether ant colonies, evolutionary biology, business organizations, or brand-positioning strategies - they shed light on dynamic processes of adaptation and survival. A business comes to be regarded as a dynamic open complex adaptive system (DOCAS), composed of inter-related parts, interacting with its environment, subject to resulting feedback effects, evolving over time adaptively to fit the pressures imposed on it, perhaps attaining a sustainable advantage, and in the process generating certain emergent phenomena.(2003: 1).*

However, there remain some issues concerning the practical implementation of complexity aware management. Despite the apparent usefulness that complexity theory offers in highlighting the potential an organization possesses for emergent behavior, it is difficult to view it in terms of a theory. A coherent, unified theoretical account of complexity has not yet been constructed (Cohen, 1999). Cohen (1999) remarks that precise definitions of the concept remain elusive and that it is more of a framework than a theory. Alternatively, complexity theory might be best seen as a metaphor that is accompanied by some key principles. We would argue that complexity theory should be considered complexity thinking as it applies to managerial practice.

Fitzgerald and van Eijnatten (2002) offer a more enthusiastic view of complexity theory, describing it as a 'metapraxis'. In other words, they suggest that it is a fundamental way of seeing, thinking, knowing and being in the world. They write: "In spite of the bad rap it has gotten from managers and practitioners who prefer to stay upstream and away from the edge of chaos, the basin of the strange attractor represents a window of opportunity for extraordinary creativity, innovation and transformation" (2000: 413). In a view not entirely shared by Brown and Eisenhardt (1998), Fitzgerald (2002) considers it a fundamental fact that complexity is not something one does and is not a program that can be implemented by an enterprise or anyone else. Nor is it a quick fix. Perhaps Keene (2000) explains it best in specifying that the key message of complexity theory is that, "our world is not only subjective, but it is the result of our interactions with each other and the environment…complexity tells us that disorder plays a key role in the creation of new and higher forms of order" (2000: 16).

To summarize so far, complexity thinking is useful as a way of interpreting certain kinds of organizational behavior and discourages managerial intervention in the form of excessive rules and control. However, we find that the practical utility of complexity thinking is grossly exaggerated. In the first place, it is not really all that new. Cohen's (1999) assessment was that there was nothing new in that a focus on systems and their dynamic properties has been a solid part of organizational science thinking in the last century. Systems theory implicitly assumes many of the key principles of complexity. On the other hand, he declares that complexity is new in that it has reached a point of mathematical sophistication and competence, and that there is a remarkable convergence in the use of the theory to explain the behavior of structures as diverse as biological, social, organizational and mathematical systems. The "wheels on the shiny, new complexity carriage are reinvented" (1999: 375), and a better understanding of the principle of emergence is useful.

Goldberg and Markoczy (2000) also believe that the features of complexity are not unique and have been well known for some time. For example, they note that in the natural sciences, the laws of gases, black body radiation and the shapes of galaxies are examples of complexity behavior. In addition, they specify that economists and game theorists have been looking at emergent phenomena for some time and have thoroughly explored how simple rules can lead to complex outcomes.

Nevertheless, this does not mean that there are no useful applications of complexity theory in management. Salem (2002), for example, argues that complexity theory offers a way to understand processes that accelerate or amplify change, as an alternative to older models that place an emphasis on rational planning and slow, incremental and diminishing change. In other words, complexity has some use in explaining how change evolves and why it is not linear like the intentions that drive it. In addition, the lack of a clear operational definition makes constructing testable questions about complexity troublesome. This leads to the conclusion that it is a concept with little demonstrable empirical validity. Until operational testing can be employed, the best we can hope for is a few pointers from studies that have descriptively charted complexity or emergent behavior in organizations on a post hoc basis.

Complexity Thinking in Use

Perhaps the most practical analysis of the utility of complexity thinking can be achieved through prosaic examples. We have already established that management principles that embrace the notions of complexity thinking are different to those undertaken with a scientific management approach (Pepper, 2003). A number of studies have attempted to clarify these differences through the documentation of cases. Tetenbaum (1998), for instance, cited the example of credit card company Visa. She described it as a chaordic system that was conceived on the basis of purpose and principle, but is structured in unexpected and unconventional ways that have developed organically as the company has grown. She also reports that the unit responsible for Sony's Playstation is constantly forced to juggle creativity and experimentation, balanced with control and efficiency. She emphasizes their ability to manage the competing tensions of creativity and competition as well as complacency and outrageousness. Tetenbaum also

explained how Motorola engaged in unintentional emergent change as a consequence of its CEO deliberately failing to provide senior management with any plans other than a broad vision in the hopes that it would stimulate their own business unit strategic activity.

In a similar set of examples, Axerod (1999) shows how CapitalOne Services used complexity theory to structure their organizations. The emphasis was on evolved effectiveness which replaced and outperformed engineered effectiveness. In other words, they found that structures that evolved naturally and perhaps, emergently, performed better than structures designed for function ahead of time. Axerod was more nebulous in explaining the way in which the US Marines use complexity theory to compute models for finding new, adaptive ways of organizing troops, a computational approach also employed by airlines such as Southwest for determining more efficient routes.

Coleman (1999) described the cellular organizational structures that have been based on complexity theory at Technical and Computer Graphics, and the Acer Group. These structures came about because senior management recognized that organizational survival and prosperity was best developed through tolerating disequilibrium. Coleman also identified the 'loose-tight' control systems employed at Sun Microsystems. This involves managing the tension between empowerment and control where outputs are measured for which people are responsible, as opposed to a focus on inputs. In addition, employees seek out each other irrespective of their relative places in the organization in order to achieve their performance criteria. This is similar to policies at General Electric that have been associated with empowerment, where trust and self-motivation have been held in high regard and the philosophy that bureaucracy crushes creativity. While self-organizing behavior may be a natural phenomenon, barriers to its emergence have been found in bureaucratic structures (Coleman, 1999).

What can we ascertain from these examples? One clear issue has to do with the way organizational structures can possess emergent properties and benefit from organic, networked evolution rather than predetermined order. Moreover, as Coleman (1999) has noted, the increased interconnectedness and self-organization of organizations has enabled their collective ideas to be communicated and converted into new products and services that the organization would not have invented independently. He advocates the creation of "organizational arrangements that do not inhibit evolutionary change and that accept discontinuous change in the environment as entrepreneurial opportunity" (1999: 38). In other words, change is encouraged when organizational design is there only to gently direct informal behavior toward goals. Pepper (2002) has counseled that leaders and managers cannot hope to exercise control over organizations that comprise independent minded professionals. This brings about too much change that can be disruptive and counterproductive. Marion and Bacon (2000) argued that loosely coupled structures – ones where components of the organizational structure affect one another weakly – allow organizations time to adjust to environmental shocks.

These examples have further commonalities with what Stacey (1996) referred to as the difference between ordinary and extraordinary management. At the ordinary level, managers make day to day decisions based on the common culture of the organization – the shared beliefs, of where and how the company should operate and progress. At the extraordinary level,

managers recognize that it is the interaction of varying groups, ad-hoc meetings, task teams and other informal mechanisms that encourage unpredictability.

Some general principles of application might now be drafted. Firstly, managers cannot control organizations that comprise people the same way that an operator can control a machine made of moving, but inanimate parts. This means that it might be more effective for leaders to define the parameters of the business, but to remain less involved in the operational conduct of the business. Indeed, it might be dangerous for managers to make decisions based upon linear assumptions about where they think the organization should head. The assumption that strict policies of governance lead to high levels of organizational control does not hold because the assumption of linear causality from policy has been shown on occasion to result in the opposite effect than that intended (Begun, 1994). Excessive rules to help employees problem-solve can communicate that they are considered incapable of solving problems, and can lead to a workforce averse to thinking for themselves and initiating innovative solutions. Stacey (1996) in fact predicted that making changes could lead to unplanned consequences, and that leaders and managers should set vision but not try to manage everything.

Secondly, macro structures can evolve emergently and might develop into unconventional networks which encourage further innovation. Organizations offer greater potential for emergent creativity and innovation when they are as close to chaos as they are from perfect order. Stability is akin to inflexibility and can signify organizational unresponsiveness and failure. Managers do not necessarily have to instill chaos; rather it is a feature of complex organizations that should be mitigated with small to moderate amounts of control and rule-making. Tetenbaum (1998) reminds us that in the modern era and, in particular with the increase in so called knowledge workers, there is less need and advantage in prescriptive working conditions. The very nature of work today is far more dynamic than work in the past. A complexity way of looking at this is useful. For example, complexity thinking explains how energy imported into a system, coupled with adaptive tension, leads to the creation of emergent behavior (McKelvey, 1999). Adaptive tension comes about in the interaction between order and chaos, and as McKelvey observed, critical complexity and emergence is formed, like a critical mass in a nuclear reaction.

Finally, complexity thinking helps to sidestep occasions when other, more conventional explanations for a situation are difficult to trace and therefore to either repeat deliberately or discontinue altogether. As a result, complexity thinking encourages comfort with uncertainty, which appears more common in contemporary organizations than ever before. If the right management philosophy is in place, there is some room for experimentation and the potential emergence of genuine innovation that could not have been forced or prescribed.

These three principles are reflected in what Tetenbaum (1998) considers the features associated with building a readiness to engage in the ‘new order’ and a culture of complexity and chaos awareness. She describes these as: knowledge and information sharing, innovation and creativity, teamwork and project orientation, diversity and strong core values. She goes on to specify several essential ingredients to the manager’s role: manage the transition, build resilience, destabilize the system, manage order and disorder, manage the present and the future, and create and maintain a learning organization.

The Verdict

Despite the efforts of Brown and Eisenhardt (1998), there is little in the way of formal evidence which demonstrates the practical effectiveness of process in management initiated complexity theory. Insufficient time has been allowed to consider long term results. Simply because complexity is valid in science is not, in itself, a sufficient or necessary reason to argue its successful transition to management theory. Certainly, some surprising results have been noted, but it does not hold that such results are always good or welcome.

The chief reason why complexity theory has become popular in management circles is because it provides a way to understand the unknowns and uncertainties associated with complex systems. The problem is that complexity theory is sometimes employed as a 'black box', removing the need to figure out what really happened within the system. Organizations are complex systems, but they are not made up of unknown units. Humans, tempered by values, irrational perspectives and selfish intentions, make up organizations. While humans can be unpredictable, this does not mean that organizational behavior does not have antecedents. It does, and sometimes this behavior has emergent properties that appear both unpredictably and spontaneously. Goldberg and Markoczy (2000) explained that when everything is known about an initial state of a system, it is possible to predict later states with precision. Complexity thinking reminds us of the limitations of cause and effect approaches, when a certain policy intervention is assumed to have a linear outcome. We should be cautious, however, before tossing aside deterministic thinking altogether.

Complexity theory, as perceived by some, diminishes the need to discover how 'things' are happening within an organization. It is one thing to be the beneficiary of an innovation in some emergent event, but is the self-organization of some useless development just as rewarding? Complexity theory is sometimes used as a stop-gap solution for dealing with a level of organizational complexity that is too difficult to trace through linear relationships, because at some point an acausal event has manifested. While managers might accept that they do not have the information required to understand how self-organization or emergent behavior come about, it does not mean that they are safe in ignoring all intra-organizational relationships.

Unfortunately, the rhetoric, misunderstanding and misuse of complexity terminology and principles also bring with it some dangers. Firstly, complexity theory is not really a theory, but a metaphor, a framework or way of conceptualizing events with certain properties in organizations. If our understanding of organizational systems were sufficiently advanced we would have no need for the concept as there would be no mystery associated with emergent behavior. This issue goes to the question of whether there is really unpredictability or just uncertainty. Secondly, complexity theory implies that order, and in particular new orders, can emerge from chaos. This is not to be interpreted as an endorsement of chaos. There seems to be confusion over the difference between chaos and disequilibrium. Facilitating chaos would seem to be an imprudent strategy in any organization, whereas complexity aware managers would be comfortable with a tension between order and chaos. Thirdly, in its truest sense, complexity theory is based on rather sophisticated mathematics. It would be unreasonable to expect that managers can 'crunch numbers' for practical decision-making. Nor is it really all that practical for most organizations

to employ consultants to devise complexity algorithms to predict ideal organizational or product structures, although this might indeed occur in the future. Finally, how does a manager take an organization to the edge of chaos but not into chaos itself? MacIntosh & MacLean (1999) express this caution succinctly:

> *The edge of chaos view, as an alternative interpretation of complexity theory, proposes that organizations are capable of perpetually reconfiguring themselves to meet changing needs as self-organizing processes facilitate the emergence of a new order. Whilst we acknowledge that this is an attractive proposition we remain unconvinced of its validity in an organizational setting. For us, there appears to be some contradiction between the notion of naturally occurring self-organizing processes and the implied need for some managerial intervention to position organizations on the edge of chaos. It would appear that the different interpretations of complexity theory operate with different assumptions about organizations; further research is needed to clarify the nature and implications of these differing assumptions. (1999: 310).*

Concluding Comments

Lynch and Kordis (1988) describe complexity and chaos theories as earth-shaking science so powerful that those who discover its direct applications will deserve to be remembered as modern Isaac Newtons. This is typical of the overstated nature of complexity theory in most managerial discussions of the topic. In reality, the principles that underpin its application are easy enough to understand, but are somewhat more difficult to practice with any precision. Caution is also needed in the use of terminology and the operationalization of the concept.

Without a clear definition of complexity and its associated properties such as emergence, it is difficult to consistently identify complexity behavior in organizations with confidence. What might look like complexity might be the manifestation of something considerably more deterministic and might be easily explained with additional research. Sometimes complex systems approaches fit data too easily (Cohen, 1999).

In organizations, complexity theory has a tendency to become a metaphor to explain unexpected outcomes as well as those that are inherently unpredictable. For example, why should we not predict innovation and creativity from the interaction of humans at the coal face of an organization? Complexity theory is therefore best seen as a device for thinking about these circumstances, and for encouraging managers to cultivate and foster the environment that facilitates emergence. Organizations are not physical systems. We should not be surprised that they betray the law of entropy. Humans have independent minds of their own and will be stimulated and inspired to create and innovate at unexpected times. The reason complexity thinking is helpful is that it assists managers to bypass old tendencies to try to control all activity in a cause and effect way. Tight management crushes the urge to be inspired from outside the system. But again, this is not such a radical paradigm. Management literature has seriously dealt with ideas of employee involvement and empowerment since the start of the total quality

management movement in the 1980s, and while the notion that change is normal rather than the exception is an interesting paradigm, it is not unique to complexity thinking (Morgan, 1997). The danger facing managers is that applications of complexity thinking become reduced to another simplistic recipe for success.

REFERENCES

Allport, G. (1968). The open system in personality theory. In W. Buckley (Ed.), *Modern Systems Research for the Behavioral Scientist.* Chicago: Aldine.

Armenakis, A. (1999). Organizational change: A review of theory and research in the 1990's. *Journal of Management*, May-June: 1-21.

Axerod, N. (1999). Embracing technology: The application of complexity theory to business. *Strategy & Leadership*, 27(6): 56-58.

Beeson, I & Davis, C. (2000). Emergence and accomplishment in organizational change. *Journal of Organizational Change*, 13(2): 178-189.

Begun, J. (1994). Chaos and complexity: Frontiers of organization science. *Journal of Management Inquiry*, 3(4): 329-335.

Blainey, G. (2000). *A short history of the world*. Melbourne: Penguin Books.

Brown, S.L. & Eisenhardt, K.M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly*, 42: 1-34.

Brown, S.L. & Eisenhardt, K.M. (1998). *Competing on the edge: Strategy as structured chaos*. Harvard Business School Press, Boston.

Byeon, J.H. (1999). Non-equilibrium thermodynamic approach to change in political systems. *Systems Research and Behavioral Science*, 16: 283-291.

Cohen, M. (1999). Commentary on the organization science special issue on complexity. *Organization Science*, 10(3): 373-376.

Coleman, H. (1999). What enables self-organizing behavior in businesses? *Emergence*, 1(1): 33-48.

Dent, E. (1999). Complexity science: A worldview shift. *Emergence*, 7(4): 5-19.

Dolan, S., Garcia, S. & Auerbach, A. (2003). Understanding and managing chaos in organization. *International Journal of Management*, 20(1): 23-35.

Dubinskas, F. (1994). On the edge of chaos. *Journal of Management Inquiry*, 3(4), 355-367.

Fitzgerald, L. (2001). Chaos: The lens that transcends. *Journal of Organizational Change Management*, 15(4): 339-358.

Fitzgerald, L. & van Eijnatten, F. (2002). Reflections: Chaos in organizational change. *Journal of Organizational Change Management*, 15(4): 402-411.

Goldberg, J. & Markoczy, L. (2000). Complex rhetoric and simple games. *Emergence*, 2(1): 72-100.

Goldstein, J. (1999). Emergence as a construct: History and issues. *Emergence*, 1(1): 49-72.

Haken, H. (1987). Synergetics: An approach to self-organization. In F. E. Yates (Ed.), *Self-organizing systems: The emergence of order*. New York: Plenum.

Holbrook, M. (2003). Adventures in complexity: an essay on dynamic open complex adaptive systems, butterfly effects, self-organizing order, coevolution, the ecological perspective,

fitness landscapes, market spaces, emergent beauty at the edge of chaos, and all that jazz. *Academy of Marketing Science Review*, 1-5.

Huber, G. & Glick, W. (1995) (Eds.). *Organizational change and redesign: Ideas and insights for improving performance*. New York: Oxford University Press.

Kanter, R.M., Stein, B.A. & Jick, T.D. (1992). *The challenge of organisational change.* New York: The Free Press.

Kauffman, S. (1994). *The origins of order: self-organization and selection in evolution*. Oxford University Press: New York.

Kauffman, S. A. (1995). *At home in the universe*. Penguin: London.

Keene, A. (2000). Complexity theory: the changing role of leadership. *Industrial and Commercial Training*, 32(1): 15-21.

Kelly, K. (1994). *Out of control: The new biology of machines, social systems, and the economic world*. New York: Addison-Wesley.

Kelly, K. (1998). *New rules for the new economy*. New York: Viking.

Kielhofner, G. (1995). *A model of human occupation: Theory and application* (2nd ed.). Baltimore, MD: Williams and Wilkins.

Kotter, J. (1990). *A force for change.* New York: Free Press.

Lissack, M. (1999). Complexity: the science, its vocabulary, and its relation to organizations. *Emergence*, 1(1): 110-126.

Lynch, D. & Kordis, P. (1988). *Strategy of the dolphin: Scoring a win in a chaotic world*. New York, NY: William Morrow.

MacIntosh, R & MacLean, D. (2001). Conditioned emergence: researching change and changing research. *International Journal of Operations & Production Management*, 219(10): 1343-1357.

MacIntosh, R. & McLean, D. (1999). Conditioned emergence: A dissipative structures approach to transformation. *Strategic Management Journal*, 20(4): 297-316.

Marion, R & Bacon, J. (2000). Organizational extinction and complex systems. *Emergence*, 1(4): 71-96.

McElroy, Mark W. (2000). Integrating complexity theory, knowledge management and organizational learning. *Journal of Knowledge Management*, 4(3): 195-203.

McKelvey, B. (1999). Avoiding complexity catastrophe in coevolutionary pockets: Strategies for rugged landscapes. *Organization Science*, 10(3): 294-321.

Merry, U. (1995). *Coping with Uncertainty: insights from the New Sciences of Chaos, Self-organization and Complexity*. Praeger, Westport, Conn.

Morgan, G. (1997). *Images of organization*. Thousand Oaks, CA: Sage.

Pascale, R. (1999). Surfing the edge of chaos. *Sloan Management Review*, Spring: 83-94.

Pascale, R. (1990). *Managing on the edge*. New York: Simon and Schuster.

Pepper, A. (2002). Leading professionals: A science, a philosophy and a way of working. *Journal of Change Management*, 3(4): 349-360.

Peters, T. (1987). *Thriving on chaos: Handbook for a management revolution.* New York: Harper Perennial.

Peters, T. (1992). *Liberation management: Necessary disorganization for the nanosecond nineties*. London: Macmillan.

Peterson, M. & Meckler, M. (2001). Cuban-American entrepreneurs: Chance, complexity and chaos. *Organization Studies*, 22(1): 31-57.

Prigogine, I. & Stengers, I. (1984). *Order out of chaos*. New York: Heinemann.

Redfern, S & Christian, S. (2003). Achieving change in health care practice. *Journal of Evaluation in Clinical Practice*, 9(2): 225-238.

Roberts, J.M. (1995). *A history of the world* (3rd ed). London: Penguin Books

Salem, P. (2002). Assessment, change, and complexity. *Management Communication Quarterly*, 15(3): 442-450.

Stacey, R. (1996). *Complexity and creativity in organizations*. San Francisco: Berrett-Koehler Publishers.

Stacey, R. (1993). *Strategic management and organisational dynamics*. London: Pitman

Styhre, A. (2002). Non-linear change in organizations: Organization change management informed. *Leadership & Organization Development Journal*, 23(5/6): 343-351.

Tasaka, H. (1999). Twenty-first century management and the complexity paradigm. *Emergence*, 7(4), 115-123.

Tetenbaum, T. (1998). Shifting paradigms: From Newton to chaos. *Organizational Dynamics*, 26(4):21-32.

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