International Journal of Organizational Innovation

A PROPOSED FRAME OF REFERENCE FOR COMPLEXITY MANAGEMENT AS OPPOSED TO THE ESTABLISHED LINEAR MANAGEMENT STRATEGIES

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Abstract

Background: As our world becomes more global and competitive yet less predictable, competitive advantage and strategic management becomes more dependent upon non-linear models and designs based on complexity and complex adaptive systems. There is no ignoring the impact of world crises like the global financial crises, natural disasters around the globe, use of cheap labor in developing economies, growing lack of natural resources, the impact of the industrial revolution and information age, developing and transient economies changing market and industry dynamics. Competitive strategy increasingly depends upon successfully managing strategies and management models that are contradictory to existing linear strategies. Existing management philosophies and models are built on principles of stability and equilibrium in a machine-like, well-behaved universe. In business, this leads to questioning the validity of existing models and acknowledging the disruptive nature of ubiquitous business enablers and the consequent turning towards complexity

Objectives: This paper justifies the reason for non-linearity and the resultant application of complexity-based modeling rather than the traditional management and design models available in strategic management and searches for the elements of non-linear solutions. These elements subsequently provide some framework for addressing strategic management as a complex construct. The objective of the paper is to present evidence that conflict with the current management thinking and to initiate a base for non-linear designs and models over the existing ones in use over the past hundred years or so.

Method: The article uses a grounded theory approach to investigate different elements for strategic management in a complex domain. The focus is not on the leadership actions but on the management models itself – those cemented in the past and a growing sense that interrelationships and instability require a new generation of models, possibly embedded in complexity science.

Results: Three possibilities are suggested in the complexity domain, one based on complex adaptive systems, the second on strategic agility and resilience; and the last on strategic paradoxes or contradictions.

Conclusion: This article justifies the need for non-linear management strategies and then continues to identify and describes three possible ways of dealing with complexity management as opposed to established linear management strategies. Three possibilities are suggested in the complexity domain, one based on complex adaptive systems, the second on strategic agility and resilience; and the last on strategic paradoxes or contradictions.

Key words: Complex adaptive systems, complex response processes, complexity in management, resilience, chaos theory, paradoxical management, innovation.

Introduction

'That when a thing lies still, unless somewhat else stir it, it will lie still forever, is a truth that no man doubts of. But that when a thing is in motion, it will eternally be in motion, unless somewhat else stay it, though the reason be the same (namely, that nothing can change itself), is not so easily assented to. For men measure, not only other men, but all other things, by themselves; and because they find themselves subject after motion to pain and lassitude, think everything else grows weary of motion and seeks repose of its own accord, little considering whether it be not some other motion wherein that desire of rest they find in themselves consisteth.'.
Thomas Hobbes in Leviathan (1651)

Business as Unusual

Thomas Hobbes saw society as a giant machine (perpetually in motion), thus the title of his great work, The Leviathan, founded on Mechanics (The Motion of Bodies/Matter). In Leviathan, Hobbes argues that the natural state of man (without any civil government) is war. Hobbes supports an absolute monarchy, where power resides in the king or queen, as this absolute power to create and enforce laws was necessary for justice and the formation of a moral society. Hobbes was close to the truth in two ways: (1) Reality exists as an interconnected 'machine and (2) motion is fundamental to reality (that means, it is real, not metaphorical).

Societal concerns (for instance, fear of nuclear events, natural disasters, the thinning of the ozone layer and provision of food and water) are exacerbated for businesses by added pressures like downsizing, restructuring and the chaotic nature of the markets. More than that, the last two decades have seen rapid growth in technological developments. There is pressure from global competitors in a once secure domestic market. This is underscored by new commercial arrangements, where diverging economies fuse to create one world economy consisting of multiple markets. The focus on trade has migrated from the Atlantic to the Pacific. Fluctuating world political and financial systems cause a questioning of values. The arrival of the Internet, the fall of the Berlin wall and the lifting of the Bamboo curtain pushed management into a world of real-time communication accessible to all levels of society. All

of these are exacerbated by, and resulted in, changing the management paradigms and strategies as we know them. Business and management are becoming too complex for existing management models and strategies. Linear management designs can no longer handle emerging complexities; the only solution seems to be to replace these by notions of discontinuous thinking.

The modern world has been inundated by catastrophic events that change the business and social environment and broke society's confidence in stability. Examples are (1) the global financial crises creating a growth vacuum and consequently filled with more regulation; (2) natural disasters around the globe and the resultant impact on global businesses because of interrelationships built into global supply chains, multinationals, use of cheap labor in developing economies, etc.; (3) growing lack of natural resources that will impact on manufacturing, service delivery and leads to lopsided supply and demand systems; (4) the industrial revolution creating substantial waste that a service/information economy cannot deal with; (5) the knowledge economy lacking a focus on the elements of linear economics (i.e. land, labor and capital) and (6) developing and transient economies taking over the production that used to belong to developed economies and not abiding by the existing rules of trade and economics.

Smith, Binns and Tushman (2010) are among authors stressing that competitive strategy may increasingly depend upon successfully managing paradox, i.e. strategies and

management models that are contradictory yet integrated. Traditionally, organizational success depends upon taking an 'either/or/ approach to choosing between paradoxical outcomes or possibilities: The external environment is assessed, and decision is made about the business model to implement this single, focused strategy. Success then depends upon the alignment of (1) the model's internal aspects and (2) its link with the external environment (Smith *et al.* 2010). A complex theory possibly provides the only platform for stability in an otherwise unruly and dynamic world. The paper shows how these are already part of our society and our lives. Moreover, there is a growing concern that the existing management philosophies and models are built on principles of stability and equilibrium – neither of these being prevalent in the twenty-first century world of work. Complexity principles could replace the mechanistic ones from the Industrial Era that were based on Newton's machine-like, well-behaved universe. Specifically then, within a business context, one should question the validity of existing models and realize the disruptive nature of ubiquitous business enablers like technology, information, market changes, structural and product changes and man himself Is there a way forward? Can the management sciences truly handle these? These issues are explored and new business models and designs proposed to deal with the challenges to our existing paradigms.

This paper forms part of a larger study into the use of complexity management in developing economies more than in developed economies because of the inherent instability

of systems in the first mentioned economies. The primary objective of the study is to determine the reasons why accepted business models mostly fail; and to provide a new paradigm for business modeling in a complex environment. This project identifies the role of complexity in organization design, opposes accepted linear approaches and complexity solutions, and proposes a framework for complexity management in strategy adoption and implementation. By the nature of complexity, this kind of organization modeling requires changing to 'softer' people solutions beyond technical ones that can accept the organic nature of the business. The outcome from the project will be a valid and reliable measurement instrument to determine the extent to which complexity should be acknowledged as well as an identification of the most significant factors that need to be addressed. This is valuable from two perspectives. Firstly, it acknowledges the major differences between developed and developing economies with regards to management and business, and, secondly, it identifies the most important factors for business success, whilst acknowledging non-linearity in strategy adoption.

Research Objectives

This paper acknowledges that linear business models are unable to deal with the above and discusses why and how a complex solution is required rather than a linear one. This poses two questions: *What are the determinants for complexity over linearity in a business environment?* And, *what are the elements of complex models in organization*

design? The paper will provide a framework for dealing with complexity in management sciences and provide three applications – in the management and the strategic management domain. It is acknowledged that, in dealing with complexity, one should not endeavor to provide a solution that in itself looks to be linear. The elements of a complex solution are in themselves also complex, even paradoxical, yet interrelated, and can thus all change.

Considerable attention has been given to agent-based models of organic systems (McKelvey 1999). In modeling complex systems, we should note that agent-based models need to avoid adoption of social concepts that assume away many of the phenomena of interest. In fact, McKelvey (1999) argues, if at least some social phenomena, which are typically assumed to arise through rational behaviour, arise instead due to complex dynamics that are little influenced by conscious intent, and then we need to allow for this in the foundation assumptions incorporated into the model design. In artificial intelligence, for instance, attempts to accommodate rational order have involved incorporating simplified rule sets or incorporation into agent design. Agent-based modeling has resulted in some valuable insight but frequently requires extensive simplification, resulting in limiting value of such models in social systems as these are generally designed to model only one aspect and lack generalizability. At their worst, such models can prove misleading if taken to be reliable analogues of real world phenomena. Also, many traditional methods of research adopt linear concepts of causality and therefore fail to attend to or even obscure complex sources of order.

The research design is qualitative as the research focuses on an emergent phenomena, i.e. the emergence of complexity science in the management sciences and on strategic management. Moreover the investigation of the research objectives in an emerging and self-organizing field 'that has no a priori referent in the world at large that is independent of the researcher's reflection and this requires new ways of knowledge creation' (Cutler 2002:1). Lastly, complex systems are networks more than they are hierarchies and thus we can only offer the following ontological premise for this research; theoretical entities do not represent any real entities unless the phenomenon follow the hypotheses in every detail and as epistemological promise that the interpretation of an observation language is determined by the theories which are used to explain and observe and such an interpretation changes as soon as the theories change.

Current Management Designs and Models

The recent world-wide financial crisis highlighted the sensitivity and interrelatedness of businesses. It also hinted at developing economies being more inclined to accept change in crises (even to live in uncertainty and instability) than developed economies because of their inherent capacity to deal with discontinuous change. Developing economies, especially, are more prone to the implementation of non-linear solutions because of the nature of the variables, the changes and interplays between the variables, the significant human focus and the consequent organic nature of the competitiveness. These variables introduce an

unavoidable element of unpredictability/randomness into any science that can be accommodated by a complex solution. Complexity management allows for pattern recognition which requires focusing on competencies, activities, technologies or resources signaling patterns that will have a positive or negative impact on strategy or operations. Simply put, strategy refers to a set of products or services and their means of competing in the marketplace (Smith *et al*. 2010).

Traditionally, any design focuses on three primary activities running sequentially: determination of the requirements, development of a solution and implementation (or building) of the solution (see figure 1). Linear modeling assumes that problems are clear and well-structured from the start; resources to be determined before the start of the project and that there

Figure 1. Traditional design principles as a sequence of discrete tasks

is a rational and predictable sequence of events (Chance 2010). New possibilities are excluded (Simon 1996).

Business as a complex system requires acknowledgement that we cannot control organizations to the degree that a mechanistic perspective will. Moreover, as the system's

environment changes, so does the behaviour of its agents. Thus, the behaviour of the system as a whole can change. Linear strategies and technologies become irrelevant with a shift to patterns and relationships between entities. A typical management system will consist of four activities – plan, act, analyze, measure (and repeat). Over time, this means that the strategy intends to make something work, then make it work properly, then better, then efficiently, then reliably and then cost effectively, and so on (see Figure 2 (a)). Of course, the reality of this model is a lot of doing, a little planning and a lot of fighting fires that are not known at the outset (Figure 2 (b)).

In contrast to traditional design strategies compromising parameter constraints to find a 'trade off' point (through optimization), Altshuller (1996) discovered that, in finding and resolving the contradictions in a system, significant innovative solutions occur. This discovery negated the myth that creativity and innovative thinking cannot be systemized. Altshuller's Theory of Inventive Problem Solving (TRIZ 1996) enhanced by Mann's Systematic Innovation breakthroughs (2009) offer innovation methodologies and tools that can be exploited by management. Their contributions helped break the barriers around out-dated management models by demonstrating how to achieve innovative management designs and models. They are not the only ones. The management sciences have seen an evolution of management tools starting with scientific management of the late 1700s (see Table 1). These techniques had one thing in common; they viewed organizational systems as linear entities

and attempted to explain and implement solutions in linear terms, i.e. more of the same. In this, Hamel and Prahalad enthused 'planning through the rear view mirror' (1994:97). In contrast, Doz and Kosonen (2010:370) state that organizations fail, not because they do something wrong or mediocre, 'but because they keep doing what used to be the right thing for too long, and fall victim to the rigidity of their business model.' They continue to argue that the business models need to be transformed more rapidly, more frequently and more far-reaching than before.

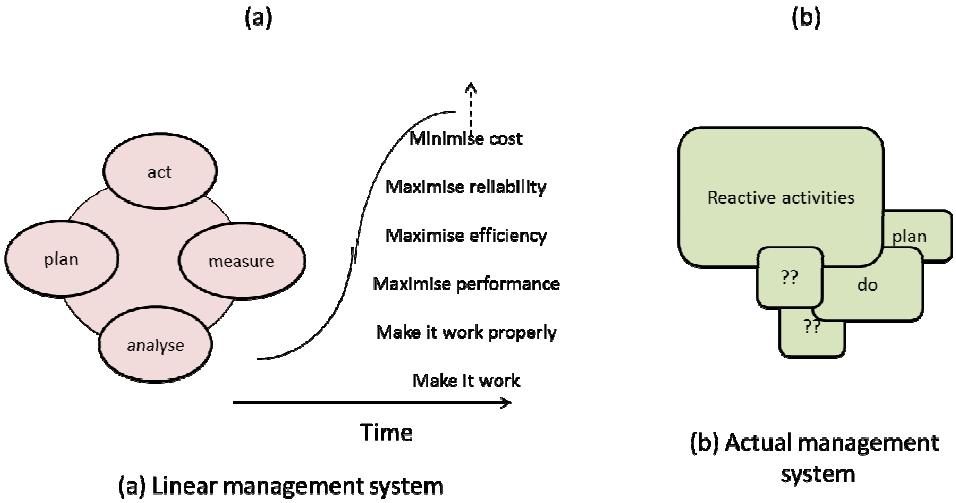

Figure 2. The elements of (a) a theoretical (linear) and
(b) an actual (non-linear) management system

These traditional management models (apart from the last one) need to be replaced by new management tools and skills to create more feasible, beneficial and ethical futures for industry and communities at large. Hamel and Prahalad (1994:211) brought two ideas into the

Table 1. Summary of the evolution of management tools and models

PERIOD	FOCUS	CONTRIBUTORS	ENVIRONMENT
Scientific management (late 1700s to early 1900s)	Specialisation, Functional Approach Work Study Assembly lines Administrative Theory Planning and Control Systems	Smith, Watt, Babbage, Taylor, Fayol, Galbraith, Ford, Sloan	Industrial Revolution World War I Depression Professional Managers
Behavioural Sciences (1940-1960)	Participation, Incentive Schemes, Ergonomics, Hawthorne Studies	Mayo, Barnard, Drucker	World War II Unionisation Reconstruction
Management Science and Systems Engineering (1960-1980)	Operations Research Simulation Modeling System Dynamics Systems Engineering Engineering Logistics, Total Quality Management	Forrester, Deming, Juran, Blanchard	Economic growth Rise of the defence industry Cold War Oil crises High Technology Investments Vietnam War
Operations Management (1980-1990)	Manufacturing Planning and Control Just-in-Time, Business Logistics Productivity Management Lean production	Ishikawa, Taguchi, Shingo, Juran	Competitiveness Rise of Japan Large military spending Economic recession
Business Transformation (1990-2000+)	Strategic Management Business Reengineering Theory of Constraints Benchmarking Information Technology, Organizational Learning	Hammer, Davenport, Martin, Senge, Goldratt, Porter, Prahalad, Hamel	Transformation of various governments New world order New socio-economic problems Dominance of IT sector
[And, more recently]: Complexity (2000+)	Complex adaptive systems (CAS) Non-linearity Collaboration Resilience Innovation	Emerging	Networked environment Pattern seeking Follows questions Technology is intrinsic Business as an organic collective

Source: Pellissier (2011, p. 162).

management sciences: '*Creating a strategic intent that dominates corporate thinking, and then understanding the core competencies [rigidities?] that the organization requires to get*

there. Rather than create numerous 5 year plans, communicate the direction and insure you have the skills to get there.' Hammer and Champy (1990) and Davenport (1993) offered reengineering as the fundamental rethink and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality service and speed. Of the many problems reengineering faced were: (1) the problem may not have been cost-cutting but growth; (2) there is an over-emphasis on processes not on people; (3) business processes are organic and have personalities because they are made up of people, having different goals, values, needs, etc.; (4) it presupposed a perfect solution by eliminating waste, wherein the 'machine' will comply with the new set of rules; and (5) IT outgrew itself and became much more than an 'enabler' to the reengineering process. The essential rules were to divide a task into several small tasks, to train/practice until an individual task is done to perfection (i.e. specialization), then place all the individual tasks in sequence in the hope that the 'perfect' process has been created. It thus taught how to analyze but not how to integrate and retain a holistic perspective.

Smith, et al. (2010:450) define a business model as 'the design by which an organization converts a given set of strategic choice (about markets, customers, value propositions) into value, and uses a particular organizational architecture (of people, competencies, processes, culture and measurement systems) in order to create and capture this value'. According to Doz and Kosonen (2010:371), business models can be defined in

two ways (1) Objectively, they are sets of structured and interdependent operational relationships between the organization and its customers, suppliers, complementors, partners and other stakeholders, and among its internal units and departments (functions, staff, operating units, etc.). These actual relationships are articulated in procedures or contracts and embedded in (often) tacit action routines. Business models can also function as a subjective representation of these mechanisms, delineating how it believes the organization relates to its environment. (2) Business models function as a subjective representation of these mechanisms, delineating how it believes the organization relates to its environment. Thus, business models stand as cognitive structures providing a theory of how to set organizational boundaries, how to create value and how to organize its internal structure and governance. Both of the above (objective relationships based on contracts and organizing routines and their collective cognitive representation) tend to be naturally stable and hard to change. The latter is further aggravated by the continued strive for efficiency and predictability (especially in periods of rapid growth). Such stability is a prerequisite for efficiency and the traditional management tools and models measure success based on routine repetition of tasks by semi-skilled workers and the convergence-to-fit phenomenon (Doz & Kosonen 2010:371). However, such stability quickly becomes rigidity leading to limited agility and an inability to renewal. Indeed, Ann Livermore, EVP of HP's Technology Solutions Group, emphasized the importance of flexibility of models (in Doz & Kosonen 2008):

'We have an advantage of having multiple models and can hence migrate products between the different business models as products and businesses mature or markets change. For instance, when we take a high-volume supply chain management (SCM) process and apply it to servers, too, the cost and time savings are huge. Developing new business models and related capabilities takes on average six years, and when we can migrate to new business models in months you can understand the difference.'

Current management models seem flawed in dealing with the increasing complexity of modern-day management, and, indeed, add to the complexity of the management system. Below are the most compelling reasons for building and applying complex models:

Taylorism

Existing management theory is embedded in the four primary functions: *planning, organizing, leading* and *controlling*. It presupposes a linear approach where inputs and outputs are related and productivity occurs when outputs are bigger than inputs, in line with Newton's three laws of motion, namely:

1. Every body remains in a state of constant velocity unless acted upon by an external unbalanced force. Thus, a body is either at rest or moving at a constant speed.

2. A body of mass m subject to a net force F undergoes an acceleration a that has the same direction as the force and a magnitude that is directly proportional to the force and inversely proportional to the mass, i.e. F = ma.

3. The mutual forces of action and reaction between two bodies are equal, opposite and collinear. Thus action and the reaction are simultaneous (Pellissier, 2001, p.27).

In 1911, Scientific Management entered the scene with the four principles of Taylor (Fayol 1987), namely: (1) replacing rule-of-thumb work methods with methods based on a scientific study of the different tasks to be done; (2) scientifically selecting, training, and developing each employee rather than passively leaving them to train themselves; (3) providing detailed instruction and supervision of each worker in the performance of that worker's discrete task and (4) dividing work equally between managers and workers, so that the managers apply scientific management principles to planning the work and the workers actually perform the tasks. Taylor insisted that it is only through (1) *enforced* standardization of methods, (2) *enforced* adoption of the best implements and working conditions, and (3) *enforced* co-operation that this faster work can be assured. He felt that the duty of enforcing the adoption of standards and enforcing this cooperation rests with management alone (Fayol 1987). From this definitive management paradigm more 'scientific' control became the norm enabling the mass-production revolution benefiting mainly the new elite (for example black Ford motor cars around 1920).

Technology Change and a New Science

Technology is changing at an unprecedented rate, and we often find ourselves adrift amidst resultant discontinuous change. There is no luxury of anticipating and planning for change, rather, as Stephen Hawking stated, "change is" (as cited in Porter-O'Grady & Malloch 2003:36). Instead of being guided by a set of concrete principles, management in the

twenty-first century must be fluid and adaptable to keep pace with changing conditions (Porter-O'Grady and Malloch). In the twentieth century, organizations focused on finding and performing the right processes, whereas in the twenty-first century, the focus is on delivering the desired outcomes (Porter-O'Grady and Malloch). The process (or work) itself does not guarantee that the intended outcome will be achieved. Our understanding of the future changes on a daily basis, and some would argue that the future is, in fact, unknowable (Stacey, Griffin & Shaw 2000). In twenty- first century organizations, relationships between people inside organizations are the domain and work of management, rather than movement toward some preselected organizational goal or benchmark. In order to thrive amidst the unknown, management must embrace new ways of being and interacting (Hamalainen & Saarinen 2006). These new ways of being, need to be consistent with the change in the nature of our workplaces. That is, management should be such that it assists to end attachments to old structures/roles and create new contexts for work (Porter-O'Grady & Malloch 2003).

Wheatley (1999) laid the groundwork for deeper investigation into the utility of the new sciences as a way of conceptualizing and understanding leadership in the twenty-first century. She focused on (1) order out of chaos; (2) information forming and informing us; (3) relationships that enrich and allow for diversity; and (4) a vision as an invisible field that can enable us to recreate our workplaces and our world. Although her ideas have been viewed by some as more metaphor than science (Stacey *et al.* 2000:143), she made ideas that had

previously been the domain of physicists accessible and compelling to a much wider audience. Wheatley reflected on Weick's (1979) observation on the dilemma organizations face: 'The environment that the organization worries about is put there by the organization' (Weick 1979:122). Axelrod and Cohen (2000) also provided a comprehensive description of complexity as applied to organizations. These authors saw the complexity science approach as having rich possibilities for bridging the gap between 'hard science' and 'humanism' (p. 159). Works such as Axelrod and Cohen, and Wheatley represent a definite move away from the mechanistic twentieth-century paradigm of leadership. However, as we start to move away from old ways of thinking, there seem to be some ideas that are harder to let go of than others.

The Living Present and a Changing Conception of Time

From a transformative point of view, the future is under perpetual construction, rather than predetermined as in rational causality. This means that human interaction that takes place in the living present perpetually modifies and shapes the future. The concept of time plays a central role in understanding organizations as complex responses processes (CRPs) and warrants further discussion. And their interactions with each other in the living present that make up an organization. We can define an organization as a temporary stabilization of themes or habits that serve to organize the experience of being together that takes place locally and in the living present (Fonseca 2002).

CRPs represent a decisive step away from the mechanistic leadership models of the previous century. Stacey et al. (2000) felt that this new terminology *(CRPs)* was needed to differentiate their view of complex; relational human organizations from the more commonly used terminology of complex adaptive systems that leads us to think of human organizations as objectified systems. The theory of CRPs is, in essence, a theory of the process of human interaction (Stacey et al. 2000). 'When people communicate with each other, conversationally or otherwise, to accomplish the joint action of living and acting together, they are, of course, continuously relating to each other in a responsive manner' (Stacey et al. 2000:188). A key concept that is essential in understanding organizations as CRPs is the idea that human communication and the act of relating occurs in the living present (here and now). The living present provides a starting point for conceptualizing causality in a new way. Rather than thinking of causality in a traditional rational way (moving toward a mature state or pre-selected goal), focusing on the living present allows us to conceptualize causality in a transformative way.

Choice and intentionality arise in, and influence, the micro-time structure of the living present. This brings us to the nature of novelty/change. In transformative causality, the future is under perpetual construction and is changed by our movement toward the future. "The future is unknowable but yet recognizable" (Stacey et al. 2000:52). From a CRP stance, human interaction is understood as paradoxical and dialectical (Fonseca 2002; Stacey et al.

2000), and our movement toward the future is movement toward an unfinished whole rather than a finished state. Having discussed the nature of CRPs and the living present as a new way to think about organizations, let us turn our attention to the role of leaders in CRPs.

Non-Causality and More Systems Thinking

One concept we seem reluctant to let go of from the bygone Industrial Age is the rational view of causality. The rationalism of the twentieth century framed the organization as progressing toward predetermined or preselected goals (the rise and popularity of strategic planning in the twentieth century is a manifestation of rationalist causality). The rationalist view of causality is that organizations are moving toward a future that is preselected by the organization or toward some other finished state (Stacey et al. 2000).

Another lingering organizational lens used extensively in the twentieth century is systems thinking. In a sense, systems thinking evolved as the twentieth century progressed. Early on, systems were viewed as machines, and later, we came to use systems thinking as a way to see organizations as living systems. Either way, systems thinking have been criticized for having an objectifying bias (Hamalainen & Saarinen 2006:17). That is, the person looking at the system necessarily views himself/herself as external to that system. The 'detached observer' is an easy and comfortable position for most people, as it has been used in many of the organizational leadership tools developed in the twentieth century. However, organizational life in the twenty-first century is highly complex and relational, and third-

person, detached views of organizational life fail to address the crux of leadership today. A new way of seeing and conceptualizing organizations is needed.

Informationology

"Informationology" is a contraction of the words 'information' and 'epistemology' and is the study of information roles (Shenk, 2009).Modern management has changed with the advent of an information-based economy. Information has changed interactions - with each other, with business and between businesses and entities**.** With information, there are a plethora of new meanings and decisions, there is a change in relationships and there is a change in the very way we conduct ourselves as individuals, as leaders and managers and as organizational entities. Pellissier (2001) states:

- *Relationships and communication:* Are formed across accepted boundaries. Competition is replaced by co-operation. A preference for one-to-one communication when sharing substantial knowledge. The more sensitive the information, the more we try to keep it private and hidden.
- *The elasticity of knowledge:* The value of information is a function of its utility, i.e. the specific use from the buyer. Thus, information may be expensive. The amount people are willing to pay and the lengths they are willing to go for knowledge are directly proportional to the need for it.

- *An over reliance on experts*: There is an over reliance to only accept knowledge from experts in a field, ignoring the possibility of new entrants into the information domain.
- *The trade-off between richness and reach:* Short, simple, superficial messages are easy and relatively inexpensive to communicate to a large group of people. For example, newspapers provide easy access to a variety of information, but there is little richness in the information. There is no opportunity to review the source or ask questions to determine objectivity or the source.
- *Tendency to control:* Information is power, and in an environment where there is one source of knowledge, power accrues to those who control the knowledge flow and can manage and distribute large quantities of information. In some way, the power of distribution becomes embedded in the technologies we acquire to do these functions for us.
- *Speed and innovation:* Competitive strength is measured in terms of speed to adopt change in terms of customer satisfaction. Large batch sizes decrease significantly. Continuous batches are replaced with discrete ones.

Information can be the most dangerous if not used or managed properly. It is a unique resource (sometimes) or commodity (sometimes). Information is intangible, reusable and

growable. It is completely different from the other very important resource, the people. An abundance of information does not guarantee quality or strategic value. The value of information lies in the quality, content and context of the information:

- Form, content, and time, i.e. information is only valuable if it is in the right format for use, is appropriate for use; and is available when required. Care should be taken that the information is obtained and developed for the specific purpose and can be used in a specific context.
- Care should be taken as to the richness and reach of information, i.e. the information developed should be meaningful and evocative enough to respond to (and exceed) the need and its source should be trusted.

There are many roles of information, some of which may even overlap (Shenk 2009; Anderson 1995): (1) as a complexity: the more information required specifying a system, the more complex it is; (2) as memory: information is a record of accumulated knowledge; (3) as communication: information is a means of social interaction; (4) as intellectual property: information with legally defined ownership interests; (5) as market enabler: information that permits efficient markets to function; (6) as context: information regarding the location, time or environment where the action takes place (Google in itself presents a self-organizing system organizing around and following questions asked), and, lastly as (7) enabler for social interaction: hits is highly visible in the rapidly growing social networks like Facebook,

MySpace and Twitter, by establishing links and building relationships as a 're-tribalization' of humanity as expressed by Shenk (2009:932) when he talks about strict censorship of Internet connections in repressive governments.

Growing Complexities of Resource Allocation and The Need For Different Planning Models

The process of planning has to articulate the strategy and the management of that strategy. From planning comes the vital means of connecting the mission of the present to the vision of the future. Part of addressing goals, objectives and strategy implementation, involves the allocation of resources within budgetary constraints. This handicaps flexibility by its focus on cost cutting and efficiencies. Mostly, the budget defines the plan that defines the strategy.

Peterson (1999) addressed an essential ingredient of strategic planning, i.e. the organizational and environmental interface. Institutional planning must include a comprehensive process of monitoring and adjusting for realities of the external environment (Taylor, De Lourdes Machado & Peterson 2008). Complexity encourages a segmentation of the environment. This allows for the impact of the environmental factors on resources and resource flows to be examined, which helps determine resources predictability and the environmental locus of control with regards to resource flows. The strategic management and competitive advantage processes become linear and sequential rather than being seen as one

set of activities, related and linked as one. Figure 3 shows the linearity of such a process even whilst the internal and external environment may require non-linearity.

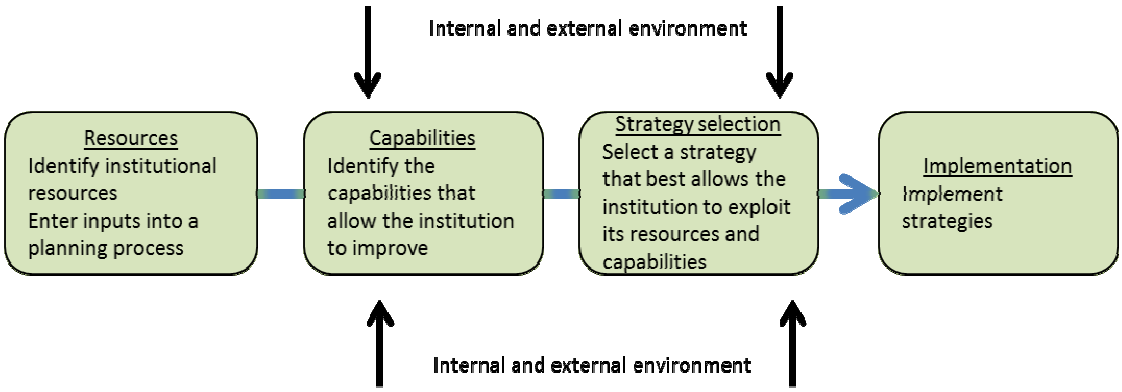

Figure 3. Using resources for strategy implementation and strategic advantage

This kind of planning relates more to operations than to strategy. Furthermore, resource allocation is not a linear process and cannot directly lead to strategy selection and implementation as is required in a linear model. This planning style does not relate to the need for adaptability with regards to the environment. The main goal of the strategic planning and implementation should focus on growth and maturity and not on internal processes and resources.

Complexity-Based Emergent Management Theory

The management sciences give us differing theories and strategies to compete in the international arena. These theories are based upon specific assumptions. These assumptions may differ. The outcomes may differ. Emergent theories confuse us further and add to the

confusion and complexity. Should we follow scientific management? Should we adopt a systems approach? Should we throw caution to the wind and adopt new technologies and focus on innovation? What about the people who need to be trained? The reality is that we can no longer ignore complexity as a science applicable to the business problems we face. There are numerous reasons for the introduction of complexity into management thinking: The management systems driving this evolution became more sophisticated at an exponential rate. There are many examples of this, for instance, Toyota's breakthroughs on improved process productivity, Shewhart's Statistical Process Control methods and Deming's TQC on improving the quality of mass produced goods, Smith's Six Sigma production-management system to enable manufacturing processes to achieve near zero defect, Altshuller's TRIZ (1996) and Mann's Hands-On Systematic Innovation (2009), moving management thinking into the space of 'structured innovative thinking'.

Complexity allows a two tiered focus in business – its performance system (responsible for the performance of current goals and tasks for immediate survival), and its adaptation system which is responsible for the long-term sustainability through the generation of new ideas, operations and behaviours. It generates possible futures for the total systems. Successful resilient organization should be robust in terms of both subsystems but tend to concentrate on only one (Robb 2000). The term complexity has two distinct applications (Standish 2008): (1) As a quality (i.e. complexity deals with our ability to understand a

system or object) and (2) as a quantity (i.e. complexity deals with something being more than complicated). Complexity as a quality is what makes the systems complex and complexity as a quantity describes, for example, human beings being more complex than a nematode worm. Thus complex systems constitute a class of systems that are more difficult to deal with than traditional analytical systems. For this reason, complex and simple systems form a continuum characterized by the chosen complexity measure. The two applications of complexity are inherently observer or context dependent, leading to a disparate collection of formalizations of the term. Thus, being able to establish easy to measure proxies for complexity is often important and most proposals for complexity are of this nature (Standish 2008:10). Complexity as a quantity can normally be decomposed in a linear way and can be directly compared (e.g. 5cm can be broken into 5 equal parts and directly compared). Complex systems on the other hand, cannot be divided and the individual segments compared. This is due to the interrelations between the subsystems that can quickly lead to combinatorial explosions. This leads to three definitions of complexity (Standish 2008): (1) The number of parts definition (a car is more complex that a bicycle because it has more parts, but a pile of sand is not as complex since each grain of sand is conceptually the same and the order of the grains is not important); (2) the number of distinct parts (since both a shopping list and a Shakespearean play consists of the same 26 letters of the alphabet, this is not a good measure of complexity); and (3) a context dependence definition of complexity.

When we relate business to a complex adaptive system (also called a learning system (Robb 2000), we look for ways to successfully adapt to changing environmental conditions. Complexity science focuses on relationships between individuals, teams or between organizations and businesses. Accepting business as being a complex system requires that we acknowledge that we cannot control organizations to the degree that a mechanistic perspective will imply but only that we can influence where the organization is going and how it will evolve. From this view, organizations are complex adaptive systems nested in larger complex adaptive systems (for instance the economy or the country it is based in or the industry it operates in). Lastly, complexity science allows an organic view of organizations and its resources. Resilient organizational structures, in focusing on the skills, culture and architecture, address this matter and will be discussed in a separate section.

Simon (1996) defines a complex system as one made up of a large number of parts that have many interactions. Complex systems change inputs to outputs in a non-linear way because the components interact with each other through a web of feedback loops (Anderson 1999:217). Thompson and MacMillan (2010:6) describe a complex organization as a set of interdependent parts which together, make up a whole that is interdependent with some larger environment. In organization theory, complexity is treated as a structural variable that characterizes both organizations and their environments. In terms of the first mentioned, Daft (1992:15) equates complexity with the number of activities or subsystems within the

organization. This, he maintains, can be measured along three dimensions, i.e. (1) vertical complexity (the number of levels in the organizational hierarchy), (2) horizontal complexity (the number of job titles or departments across the organization and (3) spatial complexity (the number of geographical locations). With regards to the environment, complexity is equated with the number of different items or elements that must be dealt with simultaneously (Scott, Gaylard, Wallace & Edmonds 1998:230). Galbraith (1982) proposes that organization design should try to match the complexity in structure to complexity in environment. Casti (1994) points out that, in non-linear systems, interventions to make a change to one or two parameters can drastically change the behaviour of the whole system. Moreover, the whole can be very different from the sum of the parts. Complex systems change inputs to outputs in a non-linear way because the components interact with one another via a web of feedback loop.

Complex adaptive systems (CAS) consist of agents that interact with each other and, in doing so, generate new behaviors for the systems as a whole.' (Lewin & Regine 1999). These lead to the following caveats: (1) Patterns of behaviour in these systems are not constant; (2) as the system's environment changes, so does the behaviour of its agents. Thus, the behaviour of the system as a whole can change; (3) complexity science focuses on relationships between individuals, teams or between organizations and businesses; (4) business as a complex system requires acknowledgement that we cannot control

organizations to the degree that a mechanistic perspective will and (5) it allows an organic perspective and the ability to deal with the human element in process design.

Furthermore, complex business models are designed to attend to the tensions of paradoxical strategies which may emanate from inconsistencies or contradictions in the products/services, marketplace, and/or processes, rewards and competencies associated with different strategies (Smith et al. 2010).

Modeling Non-Linear Outcomes

Rosen (1991) founded the school of thought believing that complex systems cannot be described by a single best model as reductionists care to believe. Instead, a whole collection of models exist that, in the limit, collectively describe the system. Standish (2008) mentions that in all cases of recognized emergence, the observer has defined at least one semantic and one syntactic model of the system. These models are 'fundamentally incommensurate' (p. 9). Moreover, emergence in this sense, can be called complex. Models that have a finite specification, can never be complex, since the specification contains all there is to know about the system.

It is not easy to compress non-linear systems into a parsimonious description. Simon (1996:1) believes that the central task of the natural sciences is to show that complexity is but a mask for simplicity. In the social and management sciences, the tendency seems to be to reduce complex systems to simpler ones by abstracting out what is unnecessary or not

important. Most organization scientists who view organizations as natural systems, point out that rules often do not govern actions and that rules can change without behavioral consequences, and behaviour can change without modifications to rule systems (Scott 1992).

Modeling normally entails encoding a natural system into a formal one by compressing a longer description into a shorter, simpler one. Since the more complex, the less knowable the organization is (Perrow 1967) it is not so easy with non-linear systems. Obviously causal models are inadequate because of the interconnectedness and feedback loops even when the relationships between the independent and dependent variables are denoted by some logarithmic or exponential function. There are six important aspects to be considered in modeling complex systems (Anderson 1999): (1) Many dynamic systems do not reach either a fixed-point or a cyclical equilibrium; (2) processes that appear to be random, may be chaotic, revolving around identifiable attractors deterministically and rarely return to the same state; (3) the behaviour of complex processes can be quite sensitive to small differences in initial conditions so that two entities with similar initial states can follow radically different paths over time; (4) complex systems resist simple reductionist analyses because of the interconnectedness and feedback loops preclude holding some system constant in order to study others in isolation. Since descriptions at multiple scales are necessary to identify how emergent properties are produced, reductionism and holism are complimentary strategies in analyzing such systems; (5) complex patterns can arise from the interaction of

agents that follow relatively simple rules, i.e. emergent patterns can appear at every level in a hierarchy and (6) complex systems tend to exhibit self-organizing behaviour, i.e. from starting in a random state, they usually evolve toward order instead of disorder (Kaufman 1995).

Modeling Non-Linear Outcomes Using Complex Adaptive Systems

There are many forms of dynamic systems, for example, general systems theory, cybernetics, chaos theory or catastrophe theory all address systems where a set of equations determine how a system moves through its state space over time. Another modeling technique examines regularity that emerges from the interaction of individuals connected in CAS. The presiding feature is that at any level of analysis, order is an emergent property of individual interactions at a lower level of aggregation. Anderson (1999), in his study of complex organizations, found that these organizations exhibit non-linear behaviors. He found that these organizations characterize four key elements that are prevalent in organization design: (1) Agents with schemata, (2) self-organizing networks sustained by importing energy, (3) co-evolution to the edge of chaos and (4) system evolution based on recombination. It follows that new models for complexity will require incorporation of these elements. Specifically, with regards to strategic direction and strategic management, complex organizations (1) establish and modify environments within which effective, improvised self-organized solutions can evolve and (2) managers influence strategic behaviour by altering the

fitness and landscape for local agents and reconfiguring the organizational architecture within which the agents adapt. Lewin and Regine (1999) identify five principles in complex adaptive systems (CAS):

1. Agents interact and mutually affect each other in a system: This focuses on relationships between and among people, teams and companies.

2. Agents' behaviors in a system are governed by a few simple rules: In business, rules become practices. These practices are guided by shared values and beliefs.

3. Small changes can lead to large effects, taking the system to a new attractor: Multiple experimentation on a small scale is the most productive way to lead change rather than to attempt to leap too quickly to a perceived desired goal on a large scale.

4. Emergence is certain, but there is no certainty as to what it will be: Create conditions for constructive emergence rather than trying to plan a strategic goal in detail. This includes nurturing the formation of teams and creativity within teams and evolving solutions to problems (not designing them). Hierarchical and central control should give way to distributed influence and a flat organizational structure.

5. The greater the diversity of agents in a system, the richer the emergent patterns: Seek diversity of people in terms of culture, expertise, age, personalities and gender, so that people interact in teams (thus creativity has the potential to be enhanced).

Most conceptual and empirical organizational modeling is based on a set of independent variables to explain the variation in one or more dependent variables. Therefore, outcomes at one level are explained by causal drivers at the same level of analysis. In CAS modeling, the question is how changes in the agents' decision rules, interconnections among agents, or fitness functions employed by agents produce different aggregate outcomes. Thus the models are multi-level because order is considered an emergent property that depends on how lower-level behaviors are aggregated. Finally, they fit into the current integrative, cross-level research in organization science. Table 2 describes each element and their contribution to a CAS model.

CAS models represent a new way of simplifying complexity by showing how complex outcomes flow from simple schemata and depend on the way the agents are interconnected, rather than reducing them to a set of causal variables and an error term. Rather than assuming that aggregate outcomes represent some homeostatic equilibrium (i.e. seek and maintain a condition of equilibrium or stability within its internal environment when dealing with external changes), CAS show that such outcomes evolve from the efforts of agents to achieve some higher fitness. All parts of a complex system should be viewed holistically, rather than focus on an agent in its local environment (which may be why the focus on processes, people or IT do not really work). In studying complex behaviour, one can even vary assumptions on the schemata, connections, fitness functions or the population

dynamics that characterize the agents (Anderson 1999). Furthermore, CAS allows for interdependencies which seem to be at the heart of modern organizations. CAS modeling and normal modeling are complimentary and should not be seen as an either-or-decision when analyzing organizations (see the discussion on paradoxes later in the paper). Causal theories and tests relating variables on the same level identify important aggregate regularities and factors that assist in creating them. CAS modeling then builds on this by explaining the observed irregularities as the product of structured, evolving interactions among lower level units. Successful models should be able to explain established findings and also predict aggregate regularities and causal relationships.

Organizational science has advanced through a combination of theoretical and empirical research. The study of CAS has been facilitated by the emergence of new computational technologies. Simulation is an obvious tool for modeling a set of complex, changing interactions over time. A limitation of simulation is that many equally plausible structures can lead to very different predictions and a given outcome can be explained equally well by a host of simulations with very different assumptions. There is a school of scientists that believe that the longer an organization has been in existence, the less likely it will allow for radical innovation (Anderson 1999).

Modeling Non-Linear Outcomes Using Agility and Resilience

The concept of strategic management is multi-faceted. The fundamental view of strategic management seems to be one of predicting the future, thinking strategically and then creating the future (Taylor, De Lourdes Machado & Petersen 2008). Gluck, Kaufman and Wallach (1980) suggest that strategic management must evolve by predicting the future (more effective planning), thinking strategically (increased responses, evaluation of strategic alternatives and dynamic allocation of resources) and creating the future (strategic planning deploying all resources to create advantage). Thus the deployment of all organizational resources, strategically driven by a flexible planning process that incorporates the institutional culture, means strategic management is at work. Mintzberg (1994) thinks that strategic management can be viewed from both a positive and a negative perspective: It provides direction to an institution and at the same time has the potential to propel it into a new direction ('perilous course into uncharted waters'). Overall managerial performance is best evaluated under the structure of a comprehensive strategic plan (Gayle, Tewarie & White. Jr, 2003). A strategy-making framework can be conceptualized that balances the opposing forces of alignment disruption (strategic thinking) and alignment creation (strategic planning), i.e. strategic management has linear and non-linear components embedded (see Figure 4). One begins with the circumstances of the present, moves into strategic thinking (which can disrupt institutional alignment), focuses on the desired future for the institution

Table 2. Elements in CAS modeling and design

ELEMENT	HOW TO MODEL	CONTRIBUTION TO ORGANIZATION THEORY Key elements of CAS modeling
Agents with schemata	At a specific level of analysis, one assumes that the outcome is produced by a dynamic system comprising of agents at a lower level of aggregation. E.g. agents =individuals, groups, coalitions; schemata=cognitive structure that determines what action the agent takes at time t, given its perception of the environment (at t or t-k). Different agents may or may not have different schemata and schemata may or may not evolve over time.	Since agents can process multiple competing schemata at any time, CAS modeling allows the possibility of evolution through a nested hierarchy of selective systems (Anderson, 1999). Anderson continues that, as schemata can evolve more rapidly than agents, CAS enjoy similar selective advantages when they allow schemata to complete and reinforce those that seem associated with favorable outcomes. One obvious advantage of this is that ideas, initiatives, innovations, creativity and interpretations form an internal ecology in the organization (McKelvey 1997). *Application to organizations* An example of a model incorporating the simultaneous evolution of agents and their schemata, is an organization that allows nine agents (each employing different rules) that all contribute to an aggregate decision. Action is taken only if all nine agents' recommendations are congruent. They have a fitness function that the organization tries to meet and a feedback function that compares the outcome of each decision w.r.t. the performance objective. Agents that contribute to successful decisions are more likely to participate in future decisions.

Self-organising networks sustained by importing energy	Agents are connected to each other by feedback loops. Thus the behaviour of a particular agent depends on the behaviour (or state) of some subset of all agents. Maintaining a self-organized state requires importing energy into the system.	Systems consist of independent actors whose interactions are governed by a system of recursively applied rules naturally generate stable structure. They self-organize, patterns and some regularity emerge without the intervention of a central controller. Drazin and Sandelands (1992) point out that, in observing order, one should search for a set of rules that explain how connections between agents at time t impact on those at time t+1. Rules thus generate structure because $state_2$=output of one application and becomes input for $state_3$. Definitely managers get in the way of activities because of their own regulation, form and self-correcting tendencies. Self-organization is the natural consequence of non-linear interaction (and not the tendency of an individual to prefer or seek order). When interactions of large numbers of components involve feedback loops, behaviors amplify and replace others. Groups of components become locked into self-reinforcing feedback cycles that lead to predictable collective behaviour. Prigogine and Stengers (1984) state that self-organization only occurs in open systems that import energy from the outside. Closed systems degenerate to a fixed-point equilibrium characterized by maximum disorder (2^{nd} law of thermo dynamics).A dissipative structure is a thermodynamically open system which is operating far from thermodynamic equilibrium in an environment with which it exchanges energy and matter. A defining feature of self-organization is a natural sequence of interaction between agents. Of course, as Weick (1979) pointed out, when there are too few components or not enough interactions among them, patterns tend not to emerge. In these cases, instead of making non-linear systems manageable by modeling complex building blocks with few interactions, one can, at least, make them understandable by modeling simple building blocks with many interactions. Order requires that the number of interactions stay within boundaries and, as such, order arises in CAS when components are partly connected. In this, Simon (1996) warns that systems where every element is connected with every other element in a feedback loop, are very unstable. In these cases, CAS form a decompositional hierarchy where elements are loosely connected. *Application to organizations* CAS modeling will require scientists to specify the pattern of connections among agents and not the pattern of connection among variables. CAS models require specifying how the behaviour of an actor at time t influences the behaviour at time t (or t+1 if there is a lag) of others with whom the actor has ties. This can be done using simulation.

Co-evolution at the edge of chaos	Agents co-evolve with one another. Each agent adapts to its environment by trying to increase the pay-off/fitness function over time. Individual payoff functions depend on choices made by other agents. Thus every agent's adaptive landscape is continuously shifting. The resultant equilibrium is dynamic not static, i.e. small changes in behaviour at time t can produce small/medium/large changes in outcomes t+1. Unlike chaotic equilibria where small changes can cause large outcomes, power-law equilibria lie at the edge of chaos (Kaufmann, 1995)	CAS theories assume that the adaptation of a system to its environment emerges from the adaptive efforts of individual agents that attempt to improve their own payoffs. Each agent is adaptive if its own actions can be assigned a value or payoff. Local adaptations lead to the formation of continually evolving niches, hence CAS operate far from the equilibrium of globally optimal system performance (Holland, 1995 and Miller, 1991). Bak (1996) proposes that all CAS evolve to a critical state that differs from traditional definitions of equilibrium. In ordinary equilibrium, small changes in the state of a system are self-correcting and the system quickly adjusts and settles back into its attractor state. In the state of self-organized criticality, a dynamic equilibrium prevails, such that small changes in behaviour can have small, medium or large impacts on the whole system. Kaufman (1995) argue that all CAS evolve to the edge of chaos, i.e. that point where small and large avalanches of co-evolutionary change cascade, because this state gives them a selective advantage. Systems that are driven beyond the edge of chaos out-compete systems that do not. *Application to organizations:* Brown and Eisenhardt (1998) suggest that the most effective organizations, evolve strategies that lie at the edge of chaos. Like Weick (1979, p. 215) they argue that organizations can continue to exist only if they maintain a balance between flexibility and stability. Furthermore, they contend that the strategic equilibrium over time is a combination of frequent small changes made in an improvisational way that occasionally cumulate into radical strategies and innovation, thereby changing the terms of competition fundamentally. The idea that a system (i.e.an organization) will experience small changes punctuated by infrequent, irregular, massive changes, is familiar in organization theory (Gersick, 1991). Most punctuated-equilibrium models set forth by organization scientists, rely on arguments that inertia builds up over time until the degree of misfit between the organization and its environment induces a crisis. Complexity theory suggests that a pattern over time of large and small changes is what one would expect from a system of co-evolving agents subjected to selection pressures.
Recombination and system revolution	CAS evolve over time by agents entering, exiting or transforming. Also new agents may form by recombining elements of previously successful agents. Links between agents may evolve over time, shifting the pattern of interconnections, the strength of each connection and its sign/functional form.	Simon (1996) points out that any adaptive entity contains an adaptive inner environment. Thus CAS are nested hierarchies that contain other CAS. These subsystems are therefore themselves subject to evolutionary pressures. Every aspect of a CAS (agents, schemata, the nature and strength of connections between them and their fitness functions) can change over time. New ones can appear. Old ones may become extinct. Existing ones can survive in a fundamentally new form. A fundamental aspect of CAS is that they allow local behaviour to generate global characteristics that alter the way agents interact (Buckhart, 1996). Actions not only proceed along feedback loops, they can also change these loops. *Application to organizations:* Technological innovations recombine elements of previous innovations (Fleming, 1998; Kogut and Zander, 1992). Groups, teams and project team forces, integrate the ideas and attitudes of their members and become arenas in which new ideas emerge from the interaction of members. Joint ventures generate novelty by recombining skills and processes inherited from the parent companies. In some corporate mergers, a new entity can emerge that blends elements from several formerly independent companies. At industry level, technological convergence can lead to the formation of new organizational communities that recombine elements of what were formerly distinct populations. These streams of research provide a rich foundation for modeling organizations as complex systems that evolve through the recombination of agents or schemata.

Source: Adapted from Anderson, 1999.

(vision) and then merges these factors into a strategic planning process (that ultimately creates institutional alignment). This evolving cycle is continuous and ongoing (Liedtka 1998). Strategic management creates an environment with consistency, but can also strangle creativity that thrives on inconsistency. With effective leadership, the negatives can be minimized.

Strategic Agility

Doz and Kosonen (2009) looked at strategic agility, believing that successful business model renewal and transformation are the main outcomes of strategic agility. They came up with specific activities that management should participate in in order to revolutionize their

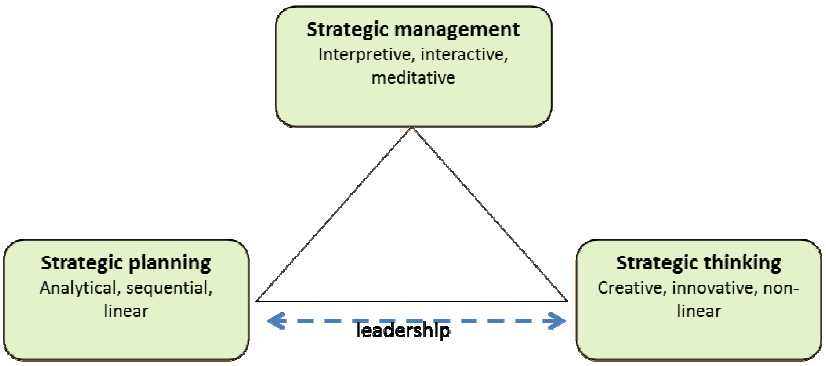

Figure 4. Strategic management as two activities: strategic planning (linear) and strategic thinking (non-linear)

business models. The authors conceptualized strategic agility as 'the thoughtful and purposive interplay' of management on three meta-capabilities: (1) strategic sensitivity (the sharpness of perception of and the intensity of awareness and attention to strategic developments); (2) leadership unit (the ability of management to make bold, fast decisions without being bogged down in win/lose scenarios; and (3) resource fluidity (the capability to reconfigure capabilities and redeploy resources rapidly) (see Table 3). They justify this by saying that (1) heightened

strategic sensitivity allows organizations to identify opportunities for new business models and also to be sensitive to the timely need for renewal and transformation of existing models; and (2) business model changes often involve hard decisions for management (this calls for adaptive and unified leadership); and, (3) resource fluidity allows firms to redeploy and reallocate their resources with regards to new opportunities and/or activities. This leads to the following sequential activities: anticipation, experimentation, distancing, abstracting, reframing, dialogue, revealing, integration, alignment, caring, decoupling, modularation, dissociation and switching in that order (see Table 3).

Inertia defends status quo or linearity. Linear strategy and linear problem solving techniques assume a rational and predictable sequence of events (Chance 2010). Problems are clear and well-structured from the start and require that resources and abilities are determined before the design phase. In fact, these prevent the designer from introducing new possibilities that present themselves in the course of implementation (Simon 1996). Strategic planning works best when seen as a continuous process of experimentation (see Table 3) that allows for multiple decisions or outcomes on many different fronts simultaneously (Leslie & Fretwell 1996). They believe that, from a management perspective, there are three caveats: linear, adaptive and interpretivist. Thus, for a strategy to accommodate non-linear aspects within or outside the organization, there are specific issues to address: (1) an iterative strategy; (2) emerging planning perspectives; (3) Decisions making spirals; (4) interactive learning and design thinking and (5) improvisation. We will discuss an iterative strategy as the other issues are embedded in this strategy.

Table 3. Developing an organizational mindset for redesign of business models/strategic management

HEIGHTENING STRATEGIC SENSITIVITY	
Anticipation	Sharpening foresight is the hallmark of strategy: This allows for deliberate reforms of business models to maintain strategic advantage and value creation. It explores future usage concepts. There should not be an over-reliance on foresight tools (e.g., scenario planning).
Experimentation	Gaining insight: Probing, discovering 'lead locations,' innovation hotspots as precursor to renewal. Change core business assumptions, or at least help define them.. Strategic and reflective use of corporate venturing.
Distancing	Gaining perspective: Being able to stand outside one's own organization allows to both model it and begin to imagine the whole system of activities and relationships. Hearing the voice of the periphery.
Abstracting	Gaining generality: From a distance one can abstract better what are generalizable. Restating business models in conceptual terms.
Reframe	Imagining new models: Considers the possibility for different model. In rigid organizations, this happens because of burning platform need. Try to develop multiple strategic frames for business model. For this, one needs high quality, open and honest dialogue around strategic issues, the use of flexible strategy teams and collaborative decision-making.
FOSTERING LEADERSHIP UNITY	
Dialogue	Surfacing and sharing assumptions, understanding contexts: Explore underlying assumptions and hypotheses at length and not as quickly as possible to reach consensus. Develop common ground. Welcome open expressions of differences. What should emerge is a collective commitment.
Revealing	Making personal motives and aspirations explicit: Transparency and clarity of motives develop mutual respect and trust and an understanding of positions.
Integration	Building interdependencies: Define a valuable common agenda that conditions success. Answer the question 'Why do we need to work together?' Work towards running, collectively, an integrated business.
Alignment	Sharing a common interest: Beyond incentives, give deeper common meanings by having a compelling mission (shared values can assist in this).
Caring	Providing empathy and compassion for empowerment: Caring companies create a capability to empathize with others and to be attuned to their emotional needs and expectations.

	These provide personal safety and mutual respect needed to attempt new things.
APPLYING RESOURCE FLUIDITY	
Decoupling	Gaining flexibility: Allow systems to evolve through modifying one element that subsequently creates sufficient tension in another that it adapts and changes.
Modularation	Dis-assembling and re-assembling business systems: Develop 'plug and play' functionality for business systems and processes.
Dissociation	Separating resource use from resource ownership: Disassociate organization structure (roles and responsibility) from the underlying business processes and IT systems and from their strategy. This allows for greater structural flexibility within a given business model.
Switching	Using multiple business models : Create different and parallel business models. Switch products between these when required.
Grafting	Acquiring to transform oneself : Difficult to initiate different business models internally Import a business model from acquired company .

Source: Doz and Kosonen, 2010, p. 372.

Iterative Strategy

In this strategy, the designer continually revisits key objectives throughout the planning and implementation process. Making use of iterative thinking, problems are defined and paired with the relevant solution. The problem is seldom known at the outset of the design, but the strategy is relatively reactive. The strategy is designed using decision-making spirals, interactive learning, improvisation and complexity theory. The complex solution will identify patterns within systems that initially appear chaotic. The solution is similar to Chrismond's (2008) design strategies rubric (see Table 4). Organizational Resilience

The concept of resilience has reached maturity over the past decade. Robb (2000) defines a resilient organization as one able to sustain competitive advantage through its capability to (1) deliver excellent performance against current goals, whilst, in paradox, (2) effectively innovating and adapting to rapid, turbulent changes in the environment. The first requires consistency,

Table 4. Planning and executing organization design using iteration

DESIGN PHASE	LINEAR DESIGN	NON-LINEAR DESIGN
Explore the	Premature decisions - make choices too soon, after reading brief.	Delay decisions - hold off from making decisions until exploring the challenging.
	Skip research - and instead start posing solutions immediately.	Do research and information searches about the problem.
	Do few or no early investigations or conduct confounded experiments.	Do valid tests to help designers quickly about the design.
Generate, build communicate	Idea fixation - get stuck on their first design ideas that they will not let go	Practice idea fluency - via brainstorming and rapid
	Describe and sketch devices that not work if built.	Use words. drawings and models explore design ideas and show parts connect and work together.
	Have a generalized, unfocused way to view tests and troubleshoot ideas.	Use diagnostic vision to focus attention on problems and ideas/devices.
Test and evaluate reflect on	Ignore or pay too much attention to or cons of ideas without also thinking benefits and tradeoffs.	Balance systems of benefits and tradeoffs when making design decisions, and use rules of thumb make choices.
	Design in haphazard ways. working whatever problems emerge. Do design a set of steps done once in linear	Do design as a managed, iterative process, using feedback to ideas. Strategies used in any as needed.
	Do tacit designing with little self-reflection and monitoring of	Practice reflective thinking by keeping tabs on design work in a meta-cognitive way.

Source: Chance, 2010, p. 48.

efficiency, elimination of waste and maximizing short-term results, whilst the second requires foresight, innovation, experimentation and improvisation, with an eye on long-term benefits (Johnson-Lenz 2009). The two modes require different skills sets and organizational designs (for example, move from JIT production to 'just-in-case' resilience). These organizations exhibit particular characteristics in the sense that they (1) can create structure and dissolve it; (2) provide safety in the face of change (although this is not necessarily security or stability); (3) manage the emotional consequences of continuous transformation, change, anxiety and grief; and, (4) learns, develops and grows. The resilience community agrees that resilience architecting (also called

resilience engineering) occurs over the three phases of a disruption. In the pre-disruption phase the system should take steps to anticipate the disruption and avoid the disruption, if possible. In the survival phase the system should absorb the disruption so that it can recover in the recovery phase. In the recovery phase the system resumes some degree of its original goals, including the survival of the humans in it. Disruptions are the initiating event that may lead to a catastrophic event. Human error is a common source of disruption. However, the resilience of the entire system will determine whether the system is prone to catastrophe. Disruptions may be either external, such as terrorist attacks or natural disasters, or they may be internal, such as human or software errors. The phenomenon in which systems fail when the components function as designed is discussed.

Resilience has four primary attributes: capacity, flexibility, tolerance, and inter-element collaboration. Capacity requires that the system be sized to handle the maximum and most likely events, such as terrorist attacks and natural disasters. However, a system cannot depend on capacity alone; the other attributes must be present to handle unpredicted events. Capacity includes functional redundancy. Flexibility requires the system to be able to reorganize. For example, plans must be in place to allow the command and control to shift upwards in the event of a serious disruption, such as a terrorist attack. Tolerance allows the system to degrade gracefully in the face of an attack. That is, all resources would not become inoperative after the first strike.

One of the most important resilience attributes is inter-element collaboration. This attribute allows all elements of the system to interact and cooperate with each other as in collaborative innovation systems. There are numerous activities relating to resilient organizations. These are (Pellissier 2011:156):

1. *Resilient organizations actively attend to their environments.* Monitoring internal and external indicators of change is a means of identifying disruptions in advance. Resilient organizations seek out potentially disturbing information and test it against current assumptions and mental models. They work to detect the unexpected so they can respond quickly enough to exploit opportunity or prevent irreversible damage. In short, they anticipate being prepared.

2. *Resilient organizations prepare themselves and their employees for disruptions.* **A**ttentive preparations build a team that imagines possibilities and displays inventiveness in solving problems. Managers know how and when to allow employees to manage them for focused productivity as well as adaptive innovation. Resilient organizations cross-train employees in multiple skills and functions. They know that when people are under pressure, they tend to revert to their most habitual ways of responding.

3. *Resilient organizations build in flexibility.* Even while executing for lean and mean performance, resilient organizations build in cushions against disruptions. The most obvious approach is the development of redundant systems – backup capacity, larger inventories, higher staffing levels, financial reserves, and the like. But those are costly and not always efficient. Flexibility is a better approach.

4. Engaging suppliers and their networks in devising makeshift solutions to temporary disruptions is a flexibility strategy. So are policies that encourage flexibility in when and where work is done. Employees who are used to telework and virtual workspaces adapt more quickly and are more productive following a crisis. In addition, research shows that flexible work practices contribute to greater employee resilience, productivity, and commitment, and to lower levels of stress.

5. *Resilient organizations strengthen and extend their communications networks – internally and externally.* A robust and redundant communications infrastructure holds up in a crisis. Social networks among employees at resilient organizations are rich, varied, and visible. People who have trust relationships and personal support systems at work and with friends and family are much more able to cope with stress and change. Good connections and communications also apply to external relationships with suppliers and customers. A key is to recognize what's important to meet organizational goals and to listen to those with needed expertise and ideas wherever they are in the value web. Resilient organizations use networked communications to distribute decision-making. As much as possible, they push decisions down to where they can be made most effectively and thus quickly. This in turn requires good access to information at all levels of the organization.

6. *Resilient organizations encourage innovation and experimentation.* In times of great uncertainty and unpredictability, the success and failure of small-scale experiments can help map a path to the future. Resilient organizations engage in market research, product development, and ongoing operations and service improvements. They invest in small experiments and product trials that carry low costs of failure.

7. Resilient organizations foster a culture of continuous innovation and ingenuity to solve problems and adapt to challenges. A side benefit is that employees who believe they can influence events that affect their work and lives are more likely to be engaged, committed, and act in positive ways associated with resilience. Some organizations also have internal idea markets to surface new ideas and innovations. Others use "crowdsourcing" to engage people externally in solving a given problem.

8. *Resilient organizations cultivate a culture with clearly shared purpose and values.* When an organization's sense of purpose is shared by its employees, suppliers and customers, those networks can provide flexibility to help it through a disruption. Engaged employees will seek out opportunities to try new approaches, find creative solutions, and achieve great results.

Chaos Theory

The relationship between chaos and complexity is sometimes contested. The range of opinion includes: chaos is a sub-discipline of complexity; chaos and complexity are interchangeable and the distinction is arbitrary; the two phenomenon have different origins and should not be considered together; the 'zone of complexity' sits at 'the edge of chaos'; the study of chaos is unhelpful and should be ignored. A useful starting point from an organizational perspective is to see complexity theory as the qualitative study of nonlinear systems drawing its metaphors from chaos theory (Gleick 2004). From an organizational perspective, the following is useful: chaos and complexity theory studies dynamic non-linear systems i.e. systems that change with time and demonstrate complex relationships between inputs and outputs due to reiterative feedback loops within the system. The quantitative study of these systems is chaos theory. Complexity theory is the qualitative aspect drawing upon insights and metaphors that are derived from chaos theory.

There are five principles pertaining to chaos theory (Pellissier 2011):

1. *Non-linearity*: Small changes can induce large effects, having little semblance to their beginning - everything beyond short-term predictions are impossible. (Link to organizational design: Technology can bring more for less. Leadership changes. Customer/technology changes).

2. *Feedback*: Output at every step in the system provides material for a new outcome, thus amplifying deviation & destabilizing the system even more, introducing new patterns. (Link to organizational design: Organizational memory allows no turning back only forward).

3. *Bifurcations*: Cusp. Occurrence can be predicted, but not the outcomes. (Link to organizational design: **r**adical change through IT, change in environment. Customers, markets, leadership).

4. *Strange attractors*: Inherent state of affairs/underlying order. (Link to organizational design: Culture, shared values).

5. *Scale*: Interpretation depends upon the scale. (Link to organizational design: Economies of scale, systems).

6. *Fractals:* Show similar (not identical) patterns at successively greater magnitude. (Link to organizational design: Systems theory, holonism).

7. *Self-organizing principle*: The ability to reorganize. Unstable combination of randomness and plan, broken by flashes of change. (Link to organizational design: Tribalism, feudalism, nationalism, customer needs & market changes, co-opetition).

Chaotic systems are characterized by three key properties: predictability, extreme sensitivity to initial conditions and the presence of an attractor or pattern of behaviour. Chaotic patterns form the signature of non-linear behaviour that arises from recursive feedback among a system's components i.e. the output of one stage feeds back into the input of the next. (This recursive or re-iterative feature is critical to complex systems as it sets the focus of attention at a local level.) Chaos theory can be used to identify patterns in systems that initially appear chaotic. The main tenets of the theory comprise of self-organization, fractals and strange attractors. Similar to the design in Table 4, chaos theory recommends using a diagnostic approach to design

of models and strategies. Chaos theory purports that certain types of issues/issues/solutions naturally gravitate towards one another in a self-organizing way. This is denoted a strange attractor as the issues/problems/solutions do not appear compatible. It allows for complementary forces to work together towards a common goal. The principles of self-organization run counter to assumptions that (1) tight control is required to prevent breakdown and (2) organizations should expend considerable efforts to rectify obvious symptoms of a problem. Chaos theory provides an excellent way to deal with external uncertainty and shocks that transcend normal planning. Informal networks of people can be allowed to develop creative ways of meeting goals and building strategies.

Modeling Non-Linear Outcomes Simultaneously Managing Strategic Paradoxes

Contradictions are not new to organizations. Lewin and Regine (1999:291) believe that, from a complexity perspective, paradoxes are not problematic and needing to be solved. Instead, paradoxes create tension from which they say creative solutions can emerge. Gavettie and Levinthal (2000), Miles and Snow (1978) point out that organizations have to be big and small, efficient and effective, operate in multiple time lines and be prospectors and analyzers. Bunderson and Sutcliffe (2002) and Flynn and Chatman (2001), point out that management teams are required to search backward and forward, be flexible and focused and learn and unlearn. It appears that successful competitive advantage and strategy will be rooted in building existing products that cannibalize those existing products. Innovation at the expense of existing products leads to sub optimal results as organizations fail to capture the on-going benefits of historically rooted efficiencies (Smith & Tushman, 2005:523). Existing products provide slack resources, knowledge and processes to launch innovation. Similarly, innovation generates new knowledge and technologies, access to new markets and increased customer awareness and

growth (Gibson & Birkinshaw 2004). This clearly indicates a shift to organizational adaptation in balancing contradictory activities. Therefore it follows that sustained performance is rooted in simultaneously organizing short-term efficiency and long-term innovation, creating a new set of organizational challenges. We have already established that an either/or approach to strategic tension is not adequate. Organizational strategy should be capable of meeting the challenges of an increasingly complex environment if management intends to exploit existing businesses and explore new ones (Smith et al. 2010). The authors continue to suggest that success over time should be rooted in and 'both/and' approach, rather than the accepted 'either/or' one in general use. Furthermore, they favour paradoxical strategies and their associated product, market and organizational designs. The term paradoxical refers to multiple strategies that are contradictory yet inter-related. This can include contradictory or inconsistent products, markets, technology and other resources that can reinforce each other. A design may be internally consistent within each strategy, but inconsistent (or contradictory) over strategies. One example of such a paradox is the competition between an exploratory strategy (focusing on the introduction of products and services that can define new marketplaces) and market exploitation (that seeks to refine and improve products in an existing marketplace). Exploring new opportunities looks into the future and involves variance-increasing activities and risk-taking. Therefore it is more successfully undertaken in organic, decentralized, flat structures. On the other hand, exploiting existing products is rooted in the past and involves variance-reducing activities and risk minimization. The latter thrives in a more mechanistic, centralized, hierarchical structure. Smith and Tushman (2005) write that, where exploitation builds on an organization's past, exploration creates a future that may be very different from the past. In fact, products coming out of exploration are often in direct competition with existing products. The work done by Smith, et al (2010) shows

that exploratory and exploitative goals must compete for scarce organizational resources and market share. March (1991) believes that successful exploration can directly oppose established exploitation, yet he feels that there is an increasing need for organizations to explore and exploit simultaneously. Other examples of managing paradoxes include the adoption of both a social and financial strategy simultaneously, strategies that are both global and local, strategies focusing on low cost and high quality (Williamson 2010), stability and agility (Doz & Kosonen 2010), learning and performance (Itami & Nishino 2010) or profitability and social outcomes (Thompson & MacMillan 2010).

Deploying such paradoxical strategies requires complex business models that can manage the inherent tensions involved and enable contradictory agendas to thrive at the same time. It also puts added pressures on management to make decisions w.r.t organizational designs and resource allocation balancing a new set of agents and schemata. Smith, et al, (2010) identified the main functions and structures that can effectively execute paradoxical strategies: (1) dynamic decision making; (2) building commitment to an overarching vision and specific goals; (3) actively learning about each agenda and the relationships between them; and, (4) engaging conflict. They believe that by enabling management to collectively support continued tensions rather than finding resolutions limit the long-term strategic opportunities. In this, they favor complex models that can host contradictions in this way in order to develop dynamic, flexible and adaptive capabilities to succeed in the short- and long-term. Smith et al. 2005; Smith et al. 2010) list three examples of complex business models, i.e. ambidextrous organizations (hosting paradoxical strategies through differentiated sub units for each revenue stream linked by targeted mechanisms and teams through the behaviors of senior management), social enterprises (hosting paradoxical tensions between the social good and financial profit strategies) and learning

organizations (hosting tensions between learning and performance, stability and change, control and flexibility, alignment and adaptability). In all of these models, resource allocation has to be decided subject to the tensions between existing products and innovation. Smith and Tushman (1999:526) developed a model to allow strategic contradictions. Their model focuses on paradoxical cognition (a cognitive frame and a paradoxical frame that allow for cognitive processing to allow for the co-existence of contradictory agendas and develop synergies and integrative results.

The idea that inconsistent and contradictory agendas exist is not new in the literature (Lewis, 2000; Poole & Van de Ven 1989). Rather, what is to be determined is to what extent and how can contradictions be supported and embraced within one set of strategic elements? The disadvantage of working with organizational tension is that it can easily provoke defensive responses leading to downward cycles. For example, Smith, et al (2010) mention a defensive response to avoid actually engaging with contradictions and to choose only one agenda and continue to over emphasize and support this – even after it is no longer required. On the other hand, engaging in contradictions enables a virtuous cycle where commitment to both strategies builds dynamic and creative opportunities. Thus tensions within complex models ensure resilience in turbulent and complex environments, thus allowing for a greater ability to respond and to innovate (Pellissier 2010).

When all elements of strategic management (structure, strategies and competencies) reinforce each other, inertia is the dominant force and there is a preference to short-term over long-term and the certainty of success over the risk of failure (Levinthall & March 1993). Sull (1999) found that these structural and psychological forces for inertia tip the balance of resource trade-offs against innovation. Paradoxical strategies change the management focus from should

we implement A or B? to implementing both A and B simultaneously. This shift in strategic focus allows for the emergence of new business models. In an increasingly competitive and unstable environment, complex business models have become a source of competitive advantage. For one, this requires allowing for internal contradictions and tensions may be an important differentiator of organizational excellence. In addition to modeling non-linear, dynamic behaviour in organizations, CAS theory has implications for strategic management of organizations.

Conclusion

Unlike systems with a fixed-point or cyclical equilibrium, the instability in the global environment, has a more dynamic equilibrium in which actions can lead to small, medium or large cascades of adjustment. Thus the aim of management and strategy is to evolve advantages more rapidly than the competition. Complexity theory is particularly relevant for organizations facing rates of external change that exceed their internal change (McKelvey 1999). In environments far from equilibrium, where change is continuous and overlapping, adaptation must be evolved, not planned. Adaptation is the pathway of an organization through an endless series of organizational microstates that emerge from local interactions amongst agents trying to improve their local payoffs. The task of strategic direction is not to foresee the future or to implement enterprise-wide adaptation programs because non-linear systems and models react to direction in ways that are difficult to predict or control. Management should rather establish and modify the direction and boundaries within which effective, improvised, self-organized solutions can evolve (Meyer, Frost & Weick 1998). They set constraints upon local actions, observe outcomes and tune the system by altering constraints while raising or lowering the amount of energy injected into the dissipative structure they are managing.

Brown and Eisenhardt's (1998) application of complexity theory to strategic management suggests that single business units achieve rapid evolutionary progress through improvisational moves based upon a few simple rules, responsibilities, goals and measures. These authors offer a new strategic paradigm for navigating the treacherous waters of modern tumultuous markets: '*the key strategic challenge facing managers in many contemporary businesses is managing this change. The challenge is to react quickly, anticipate when possible, and lead change where appropriate. A manager's dilemma is how to do this, not just once or every now and then, but consistently*.' Brown and Eisenhardt argue that '*competing on the edge is the unpredictable, often uncontrolled, and even inefficient strategy that nonetheless defines best practice for managing change*." For them and many others, *Change* and *challenge* may be the most overworked words in today's business lexicon, but there are no better synonyms to describe the possible chaos in the environment. The traditional practices of strategic definition and execution that appeared to work well until recently are no longer even effectual. Determining an end-point, agreeing on basic assumptions, and mapping the process toward a fixed objective over a defined period of time no longer work. Following a map that fails to represent a constantly changing landscape seem foolhardy. They conclude with ten laws for competing on the edge: Advantage is temporary, strategy is diverse, emergent, and complicated, reinvention is the goal, live in the present, stretch out the past, reach into the future, time pace change, grow the strategy, drive strategy from the business level and rematch businesses to markets and articulate the whole.

Synergy amongst units follows when units have distinct roles participating in the larger focus. Collaboration is focused on a few key areas. Evolution is preferred over the radical revolution preached and implemented by the re-engineers of the 1990s. Portfolio elements should be recombined so that novelty is deliberately generated without destroying the best

elements of the past experience. Management can either alter the fitness landscape for local agents or they can reconfigure the organizational design within which the agents adapt. In both cases the strategist operates on agents directly, taking advantage of the many local interactions to self-organize into a coherent pattern. More than sharpen the pattern that constitutes a strategy, management shapes the context within which it emerges. The role of CRPs and CAS models can no longer be ignored.

There is no dispute in the research of the last two decades that new management models are required because of the changes in the world as we know it. Organizations are living systems, organic and made up of the people, the processes and the technologies, all of which are changing. CRPs and CAS provide an approach to the management sciences and particularly to strategic management, to rethink the linearity of our designs and systems and to allow for equilibrium to take place. It requires us to acknowledge that paradoxes can exist, even be embraced. Paradoxes in themselves fluctuate at the edge of the mechanistic and the organic. Although the idea of paradoxes can in itself be viewed as an either/or view of the workplace, used correctly it provides synergy and allows for better long-term planning without letting go of the short-term objectives.

Future research can model innovation and renewal as the outcome of interaction among a variety of organizations that pursue better technical performance in a co-evolutionary competition with each other. The following empirical data should be collected: Who are the agents? How many organizations compete in this space? What are their salient characteristics? What are the agents' schemata? How are agents connected? How do these connections change over time? What pay-off functions do these agents pay attention to? What trade-offs are they willing to make among different pay-offs? How do these actions affect the payoffs of others?

What is the pay-off structure of the evolutionary game they appear to play? In understanding how organizations can effectively manage their paradoxical (internal and external) environments remains a critical question for management scientists. In the end, decisions are made by top management. Thus, new leadership challenges and decision-making are required and need to be researched to allow for these models to be implemented. What we did not address, was a determination on which organizations, industries or countries are more suited to complex design models (our scan through the literature indicated advancements in health sciences and education using some form of CAS). Or more so, would manufacture or service industries be similar in their approaches? Or would industries directly related to technology change be the ones to address these issues first? At what stage in the organization life cycle is it preferred to allow complexity? These should still be determined. The theoretical frameworks exist, it is up to modern management to change their mindset and use these.

Lastly complexity is neither complicatedness nor over-determination. Complexity science is fundamentally a new way of looking at physical, biological and social phenomena. It is a cross-disciplinary field with its own approach to knowledge-creation that includes a set of methodological approaches. As such, it offers distinct and innovative perspectives on the evolution of systems and the behaviors of the actors within them. And, note that complexity in itself is not an either/or to traditional management models. Instead, it expands and augments these models.

> *'Organization theory has historically borrowed from a number of parent disciplines. Because complexity theory has developed along a very interdisciplinary path, it may be that in the end, organization theory contributes as much as it borrows to the development of insight into the behavior of complex systems. Many modern organizations are complex adaptive systems par excellence, and we who study them should eventually lead instead of follow efforts to understand the fundamental nature of non-linear, self-organized structures.'*
> *Anderson, 1999, p.230.*

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