The Implementation of Resilience Engineering to Enhance Organizational Innovation in a Complex Environment

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Abstract

Becoming globally competitive has requires specific skills in developing economies as these environments are far more complex. 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 decision making techniques become irrelevant with a shift to patterns and relationships between entities. 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 management decisions. Complexity allows for pattern recognition which requires focusing on competencies, activities, technologies or resources signaling patterns that will impact on innovation, especially with respect to organizational, management and technological forms. Technology as knowledge is an intrinsic part of the pattern recognition the implementation of the above forms of innovation. This paper discusses the role of non linear management theories in a complex environment with regards to these innovations. In this sense, a resilience engineering approach provides the space for innovation implementation and the focus on organizational and management innovation through complex adaptive systems. The literature abounds with research on product and process innovation but less is said about organizational, management or technological innovation and their implementation.

Keywords: Complexity, Pattern recognition, Organizational and management innovation, Resilience engineering, Strategic management, Management decision making, Competitiveness

1. Preamble and Scientific Justification

This is a position paper presenting an 'academic' perspective on the question on what is beyond current innovation practices with regards to organizational renewal. It also redefines innovation in terms of the complexity of the new world of work. The question presented, raises issues of complexity and issues of linearity. The answer may be unconvincing to some and strange to others, but then, so is the very nature of innovation. John Naisbitt (Hamel, 2000), maintains that '*Academics are afraid to go beyond data. Alfred North Whitehead said that a proposition doesn't have to be right, it just has to be interesting. Academics don't understand how liberating it is not to have to be right. When you have to be right, you become a prisoner.'* we will not try to defend my solution here; it is for the reader to prove me wrong. In this, we hide behind Stephen Hawking's understanding of scientific proof in that, if you cannot find us wrong, then yes, we could be right! Hawking argues that there are two requirements for any theory to be true:

1. It must accurately describe a large class of observations on the basis of a model that contains only few arbitrary elements and
2. It must make definite predictions about the results of future observations.

According to him (Hawking) any physical theory is always provisional in the sense that it is only a hypothesis – one can never prove it, only disprove it. Thus, no matter how many times the results of subsequent experiments agree with the theory, one cannot predict whether the next time, the result may not contradict the theory. On the other hand, to disprove a theory, one only has to find a single observation contradicting the theory. Thus, a new theory really is an extension of the previous theory. In practice, a new theory may be devised following upon add-ons to the previous theory, through modifications or even abandonments. (An example of such is that of Newton's laws of gravity, which in essence, have been proved not correct by Einstein's predictions. However,

since Newton's laws are simple and the difference between its predictions and those of general relativity is very small, Newton's work stands.) Moreover, Heisenberg's uncertainty principle allows uncertainty until that outcome or result can actually be observed to take place.

Therefore, you are invited to build on this theory by arguing, or disagreeing but be sure to add something that can make it grow. This paper redefines innovation in terms of the complexity of the world of work currently experienced and links resilience engineering and complexity for new forms of innovation in terms of its organization and its management.

2. Innovation is Renovation

Up until recently, we would have maintained that information technology (IT) is unambiguous. That is still true. But beyond that (e.g. IT), value lies in the information and knowledge obtained, distributed, shared, distributed and created. And, when that is done, innovation begins. And, when that is done, there is more innovation. To us, innovation is not invention or entrepreneurship on a grander scale. Innovation is knowledge used in a unique and different way. Innovation is new thinking. That thinking can be radical, disruptive or incrementally different. But it is not more of the same. It is renewal and renovation.

The rise of the 'networked' or 'information' economies (Castells, 2000; Nonaka et al, 2001; Roos, Roos, Draonetti & Edvinsson, 1997; Volberda, 1998) signified by terms such as 'intensive', 'innovative' and 'flexible' suggest that firm performance is increasingly predicated on the efficient and effective use of knowledge (Grant, 1996). Acting knowledgeably, rather than repetitively, is becoming critical because not only does it prompt learning from experience and provide insight into possible commercial futures, it is hard to imitate and can be strategically distinctive (Kogut and Zander,1992). Innovation is generally the result of cumulative dynamic interaction and learning processes involving many stakeholders. Here innovation is seen as a social, spatially embedded, interactive learning process that cannot be understood independently of its institutional and cultural context (Cooke, Heidenreich, and Braczyk, 2004; Lundvall, 1992; Fornaciari & Dean, 1998). Since Roberts'(1999) definition (of innovation) maintains that an innovation can only be seen as innovation if it is has implementation and commercial value, it is important to measure the impact of innovation. Ravichandran (2000: 263) believes that measuring the impact of innovation activities will depend on (1) the typology, (2) the degree of departure from the preceding product/service or process, (3) the extent of usefulness of the innovation and, (4) the volume of profitability generated. Smith (2010) identifies four types of innovation based on the work done by Henderson and Clark (1990): *incremental* (refining and improving the existing design within an established architecture), *modular* (use is made of new technology and components, within an existing system); *architectural* (an established system links existing components in a new way), and *radical* (involving a total new design using new components). In the last case the innovation can be disruptive. Henderson and Clark's framework shows that systems and components in innovation are inextricably linked. For instance, architectural innovation reconfigures an established system to link existing components in a new way.

We define innovation as a continuum of activities as below: Innovation as renovation is the outcome of a series of interrelated activities on a continuum, starting with creative discovery, then entrepreneurship, and, finally commercial exploitation. In this, leadership is redefined, processes, systems and culture may be redesigned and organizations search for and find new meaning. This definition allows for product/process innovation but also includes organizational/management/technological innovation activities.

[INSERT FIGURE 1: INNOVATION AS A CONTINUUM OF ACTIVITIES]

The more well-known forms of innovation are *process innovations* ('performing an activity in a radically different way', Davenport & Pruzack (1993:10); *service innovations* ('a new way of providing a service, often with a novel and very different business model even an entirely new service', Smith (2010) and *product innovations* (' a core design concept that performs a well-defined function', Abernathy & Clark (1985). Product/process/service innovations thus comprise both systems and components, calling for an integrative model for innovation beyond the either/or instrumentalist vs. radicalism approach of the past. Organizational innovation encompasses all of these whilst highlighting the the way businesses operate (Birkinshaw, Hamel, & Mol, 2004). These authors maintain that organizational and management innovation is difficult as it questions existing practices and processes and our assumptions on the nature of the way things are.

While innovation concerns the processes of implementation, relying mainly on organizational communication and power, in the domains of production, adoption, implementation, diffusion, or commercialisation of creations (Spence, 1994), creativity remains exclusive to the relation established between the creator and his product, where not even originality and usefulness are important, but only the notion of 'trying to do better'. The latter is connected to cognitive and emotional processes taking place at the individual level (Sousa, Monteiro, &

Pellissier, 2008; Sousa, Pellissier & Monteiro, 2009a and Sousa, Monteiro & Pellissier, 2009b). If we relate creativity to problem definition, and innovation to decision implementation, this last step requires a series of problem definitions, in order to carry out a decision or an idea, thereby making it difficult to separate these concepts at an organizational level. In fact, when we move from the individual level to the team and organizational levels, creativity and innovation become more and more difficult to separate, so that we must agree with Basadur (1997), when he says there is no difference between organizational creativity and innovation. Therefore, the moment we move to other levels besides the individual, we will use these terms (creativity and innovation) as synonyms, and we refer to organizational creativity as a *system devoted to enhance creativity in organizations,* thus using the definition proposed by Basadur (1997).

As to the several approaches to identify types of innovation, either by separating the adoption of products and processes from its development (Cebon, Newton & Noble, 1999) or, in a more classical way, product and process innovation (Adams, 2006), most authors agree that innovativeness, or organizational (and management) innovation, is a separate type of innovation, which represents the potential of the workforce to promote changes to benefit of the organization. As Huhtala & Parzefall (2007: 299) mention, '...to remain competitive in the global market, organizations must continuously develop innovative and high quality products and services, and renew their way of operating', and they also maintain that companies increasingly rely on the employees continuous ability to innovate. Also, even though innovation may take place through the adoption or development an existing product or service, through investments in R&D or in technology acquisition, it is only through developing and sustaining a creative workforce that the organization will succeed in maintaining the necessary potential to overcome difficult problems and situations that cannot be solved through investments only (Cebon, Newton & Noble, 1999). To this end, technological innovation is seen is created as a result of an innovation activity comprising research (scientific), technical, organizational, financial and market activities. Technological innovation means objective improvement of the properties of a product or a process or a system of delivery relatively to the already existing products and processes. Less significant, technical or esthetical modification of products and processes which do not influence the performance, property, costs nor materials consumption, energy consumption and components consumption are not considered technological innovations. As Desrochers (2001) puts it, technological innovation can manifest in any business activity, for example in a basic activity, as well as in secondary and other activity (as defined in the system of national accounts), and in the auxiliary activity of sales department, accounting department, IT department etc. (e.g. computerisation of a sales department or a finance department of the enterprise can be considered a technological innovation).
The creative workforce potential is both the ability to retain creative managers and employees (McAdam, 2006) and to provide an environment where each one will feels free and willing to contribute to organizational success. Aspects like raising job complexity, employee empowerment and time demands, together with low organizational controls (decision making, information flow and reward systems), are said to raise employee creativity (Adams, 2006). However, more elements are necessary in order to make people willing and able to contribute to organizational effectiveness. For instance, supportive leadership, knowledge acquisition, and team work procedures favouring creativity (Unsworth, 2005) can add to success. Creative people (either managers or employees), are committed to their work and organization, and so they may bring in important issues, provided that top management values their work and ideas. In fact, according to a Gallup Management Journal (GMJ) survey (Hartel, Schmidt & Keyes, 2003), engaged employees are more likely to 'think outside of the box' and produce creative ideas than disengaged people; they also are more receptive to new ideas. The research concludes that engaged people tend to find and suggest new ways to improve their work and business processes, which may lead to the assumption that creative people have a deeper understanding of the organizational processes, by being in a privileged position to identify, define and find organizational problems.

To a certain extent, most of these can be achieved by the implementation of complex systems and the concept of resilience engineering to the business fundamentals. This is attained by elevating the importance of creativity and entrepreneurship and providing a system through which current goals are realised by new ideas can flourish. What are required are freedom to create, content and process skills to be able to create, and a supportive human environment (peers and team leader). The issues surrounding the potential of an organization to innovate are still in its beginnings, although Mclean (2005), Puccio, Firestien, Coyle & Masucci (2006) and especially, Basadur and others (1993, 1996, 1997, 1999, 2000 and 2002), did some empirical research. The major challenges are to define criteria to evaluate the impact of organizational innovation on process and product innovation (Wolfe, 1994).

Innovation within the framework of a knowledge-based economy goes far beyond the linear or chain linkage models that have long been used in innovation theory to explain innovation processes in high-tech knowledge

industries. Here innovation is seen as a social, spatially embedded, interactive learning process that cannot be understood independently of its institutional and cultural context (Cooke, Heidenreich, & Braczyk, 2004; Lundvall, 1992). Strambach (2002) suggests that the interdisciplinary view of innovation systems is concerned with understanding the general context of the generation, diffusion, adaptation and evaluation of new knowledge, which determines innovativeness. It follows that the focus is on non-technical forms of innovation as defined above. Common characteristics of the different approaches to innovation, identified by Edquist (1997), include (1) innovation and learning at the centre, (2) a holistic and evolutionary perspective, and (3) an emphasis on the role of institutions. The increasing interdependence of technological and organizational change is a significant feature of systems of innovation, which means that technological innovation and organizational innovation have become increasingly important. These are combined with more diverse knowledge requirements which include not only technical know-how, but also economic, organizational, and sociological knowledge and competencies. The second reason for the increased interest in non-technical innovations is associated with the connection between the organizational innovation and the corresponding learning capacity. The acceleration of change that is part of the globalization process means that organizational learning processes are more and more important for creating and maintaining competitiveness.

In organizational innovation, the unit for innovation is the organization itself (Wolfe, 1994). Although the outcome of the innovation may be process, product or service, the innovation needs to be undertaken through the creative inputs of the individuals and/or the management. As to measures of innovation, Dalal (2008) mentions that the qualitative measure of emotional and psychological impact the innovation produces on the users (the 'aha!' moments); the quantitative measures of the total population of end users using the new innovation (and even helping co-create it), and the net new revenue generated for the company that can be attributed to the new innovation. Thus, while innovation concerns the processes of implementation, relying mainly on organizational communication and power, in the domains of production, adoption, implementation, diffusion, or commercialisation of creations (Spence, 1994) creativity remains exclusive to the relation established between the creator and the product, where nor even originality and usefulness are important, but only the 'trying to do better', connected to cognitive and emotional processes taking place at the individual level (Sousa et al., 2008).

Some innovation theorists like Smith (2010), believe innovation is meaningless without technology. We do not think so. Technology is a great platform for innovation achievement, but it is certainly not the only one. Technology is a good enabler for certain types of innovation. But real innovation comes from the inner self and individual contributions (in figure 1 we used creativity and entrepreneurship in this regard) and thoughts need to be given a place in organizations and in society to breed. We maintain that innovation takes place in the specific domains of product, process and/or service. However, there is more: innovation also takes place in leadership, culture, processes and systems, design, products and technology. Innovation is a thinking skill more than a doing skill. It transforms our views of current reality and focuses on renewal and regeneration. Danah Zohar (1990) believes that *'Most transformation programmes satisfy themselves with shifting the same old furniture about in the same old room. Some seek to throw some of the furniture away. But real transformation requires that we design the room itself. Perhaps even blow up the old room. It requires that we change the thinking behind our thinking – literally that we learn to rewire our corporate brains.'* Zohar's 'real transformation' is really innovation.

The question to be asked is how strong is the link between innovation and real transformation. Our best contribution after days of deliberation and sleepless nights is **42** (after Douglas Adams' (1980) famous computer by the wise name of Deep Thought). Deep Thought had an answer for a vague question, but innovation sometimes takes place in an intuitive domain where there is no specific question (see serendipity). Either that or we do not know. We deeply believe that we have not at all tapped into our inner genius and the exploration of our own innovative sensibilities. Maybe we are afraid. Maybe we are so cultured to behave rationally and according to preset patterns that we consciously simply cannot remember how. As informationologists, we believe in the advantage and power of information and knowledge. If we try really hard, it is possible to design appropriate systems and technologies in place to obtain these. Then we need to do something with them. That makes Information Science and Knowledge Management possible. Creating space for innovation is more complex as it is not derived out of systems and technologies and has no theory to guide it; it comes from the inner self and only to those who are not afraid of newness. We thus turn to Jaworski's Synchronicity principles (1996). He says: '*Because of our obsessions with how leaders behave and with the interactions of leaders and followers, we forget that in its essence, leadership is about learning how to shape the future. Leadership exists when people are no longer victims of circumstances but participate in creating new circumstances. When people operate in this domain of generative leadership, day by day, they come to a deepening understanding of 'how the*

universe actually works'. That is the real gift of leadership. It's not about positional power; it's not about accomplishments; it's ultimately not even about what we do. Leadership is about creating a domain in which human beings continually deepen their understanding of reality and become more capable of participating in the unfolding of the world. Ultimately, leadership is about creating new realities' [(Jaworski, 1996). Now substitute 'innovation' for 'leadership' and 'innovators' for 'leaders' in the above:

- Because of our obsessions with how innovators behave and with the interactions of innovators and followers, we forget that in its essence, innovation is about learning how to shape the future.
- Innovation is about creating new realities.

After all the definitions for innovation and innovators we have participated in constructing or have seen, this is by far the most encompassing in terms of complexity. However, it makes out innovators and their contributions to be different and it links leadership and people (more than technology) to innovation. This links innovation to quantum thinking and complexity science.

3. The Quantum Approach to Management

Innovation takes place in a quantum environment that is the antithesis of the clock-work based Newtonian world (thesis) we feel safe in. Although it is true that quantum (generally non-linear) thinking and Newtonian (generally linear) thinking are perceived to be on the Hegelian dialect of opposites, we do not believe there should be an either/or here but rather we should beg and borrow from both worlds to find synthesis from both. The principle of dialect is a known one and examples abound:

- In 1852, Riemann created a new geometry that did away with the Euclidean geometry. Riemannian geometry is about space, curved surfaces and multiple dimensions. It is only recently that the significance of his insights have been realised.
- In 1904, Einstein was working on his Theory of Relativity. However, he did not have the mathematical formulae to make his theory work, and it was not until someone showed him Riemann's theorems that he had the answer. Space-time geometry is Riemannian. Einstein's theories held until the emergence of Quantum Mechanics in the 1930s.

Let us juxtapose these worlds, and the thinking behind. The graphic below (figure 2) shows the evolution of different worlds not dissimilar to Toffler's well known epochs (Toffler, 1980; Pellissier, 2001). This one, however, is not based on needs and valued-added activity but on thinking and doing. Over time, and as knowledge grows, it takes us though a Plato-est ideas state of 'true/false' concepts (or on/off depending on the language we use) that converges into a mechanistic world of rules and laws that govern all decisions and behaviours, diverging into a quantum world of chaos (and order) and complexity. The quantum thinking paradigm is not a bad one as [quantum mechanics] ' *does not predict a single definite result for an observation. Instead, it predicts a number of different possible outcomes and tells exactly how likely each of these is'.* Thus, if one made the same measurement on a large number of similar systems, each of which started off in the same way, one would find that the result of the measurement would be A in a number of cases and B in a different number and so on.' The reader will see the direct analogy to accepted practices like scenario planning and simulation activities. There are five main caveats of the quantum principle that are relevant to the modern world (although the analogy still needs to be scientifically proven). These are that energy is continuous but comes in small but discrete units; the elementary particles behave both like particles and like waves; the movement of these particles is inherently random; it is physically impossible to know the position and the momentum of a particle at the same time. The more precisely it is known, the less precise the measurement of the other is and the atomic world is nothing like the world we are used to. Equilibrium can be upset by some force (external or internal).

These certainly make sense from an innovation (or regeneration) point of view as it presents a space for randomness and uncertainty.

[INSERT FIGURE 2: CHANGES IN MANAGEMENT THINKING]

In the figure above, we made the point of the mechanistic worldview converging and/or diverging to the quantum one. There is reason to believe that, although we all maintain to embrace non-linearity, we cling desperately to rules for comfort. Thus, in some unique way (of which the answer may be 44), these worlds should not diverge. Below are the opposing principles in Newtonian and quantum physics. The optimum solution would be to be able to tunnel, i.e. jump from linearity to non-linearity and back, depending upon the need. This of course provides us with far more competencies than before - the *only* requirement to be so non-linear as to be able to acknowledge a space for linearity!

[INSERT TABLE 1: NEWTONIAN AND QUANTUM PHYSICS PRINCIPLES]

The analogies to Newtonian and quantum management thinking are be summarised in table 2 below.

[INSERT TABLE 2: NEWTONIAN AND QUANTUM THINKING PRINCIPLES]

Quantum thinking necessitates newness, like communities of practice; open and creative space; borderlessness; group actualisation; creativity, courage and renewal; innovative leadership; metaphors; appreciative enquiry and discontinuity.

From a modelling perspective, built on our understanding of science it is clear that there is a fundamental shift that needs to take place within organizations. Zohar (1997) implies that through thinking differently, one can help create new ideas for organizational design; she states that, '*The essence of quantum thinking is that it is the thinking that precedes categories, structures, and accepted patterns of thought'* (Zohar, 1997: 21). Thus quantum' thinking, in line with complex environments, will lead to new organizational theories in design and subsequently leadership definitions to cope with these in organizations.

A Newtonian world view has structured organizational modelling based on the separation of parts within this fundamental science into an unconscious administration of a rigidly structured design that has forced the segregation of organizational parts and participants into divisions and separate structures (Kilman, 2001). The space between these internal participants and external organizations are implicitly ignored and are only relevant once a reaction to an external stimulus is required. Organizations today are rigid structures, controlled from outside the system and the white space between organizational participants is implicitly ignored (Kilman, 2001). Wheatley (1999), states that the machine imagery (of Newton's theories) is captured by organizations in an emphasis on structure and parts and links this to the machine imagery of Newtonian-Cartesian physics: '*Responsibilities have been organised into functions. People have been organised into roles. Page after page of organizational charts depicts (sic) the workings of the machine*' (Wheatley, 1999: 29). This separation of the system has led organizational designers to design organizations and value chains upon principles of parts interacting along a continuum managed through force and reaction, in line with Newton's laws of motion. Shelton & Darling (2003: 353-361) relate this design directly to Newtonian-Cartesian scientific principles and the management theorists that utilised these principles to design organizations: '*Newton's thinking had enormous impact, not only on science, but on organizations as well. The founding fathers of industrialism were greatly influenced by his worldview. Newton frequently characterized the universe as a great clock-like machine and his machine metaphor was transferred to the workplace…Data were (sic) collected and analyzed (reductionism); prediction was highly valued (determinism); and what could not be measured simply did not exist (positivism).'* These structures and categories to design, manage and lead organizations, now seem to have been 'formulated for life in simpler times when organizations were viewed as stable entities that functioned in a logical, linear, predictable manner' (Shelton et al, 2003: 353-361).

In stark opposition to this philosophy, is the quantum worldview that, through a shift to a systems thinking paradigm, in line with quantum, thermodynamics, complexity and chaos theories, is a shift away from thinking of the parts above to a paradigm of a system as a whole, where fractals will determine new organizational constructs at the edge of chaos, within a system of bounded instability (Senge, 1999; Zohar and Marshall, 2004), through the interconnectedness of people (Kilman, 2001), aligned to a central vision of 'meaning' (Zohar 1990). This is corroborated by Kilman (2001: 69), where he suggests that a principle for quantum organizations must be the '*inclusion of consciousness in self-designing systems, which will lead to the eternal self-transformation of flexibly designed organizations'*.

Once guiding principles (guiding visions, sincere values and organizational beliefs) have been agreed, Wheatley (1990:144-146) highlights two fundamental shifts that organizations need to make to become quantum thinking organizations, that operate in this new structure. The first shift must be a shift to *systems thinking* and the second shift moves structured organizational dynamics into the organising dynamics of a *living system.* The future of integrated extended organizations and value chains is inherent in the value or 'meaning'. Wheatley sees this dynamic organizational system as a relationship of networks. The integration of this dynamic system, writes Wheatley (1999), is through the three elements of (1) *identity* (ability to manage the shapes in motion of an organization around a central tenant of meaning), (2) *information* (the integration of organizational learning) and (3) *relationships (*beyond the traditional boundaries to establish relationships with people anywhere in the system), as supported by Jaworski (1996) and Kilman (2001), where Kilman states that in quantum organizations, active participants must have empowered and empowering relationships.

The perpetuation of Newtonian thinking has continued to be expressed within the human resources field. Many academics and organizational theorists are of the opinion that management unconsciously administers a rigid inflexible organization, that employees have been reduced to passive jobholders who are externally controlled

and employed to administrate and not to think, which is furthermore structured by the segregation of jobholders into organizational roles and responsibilities (Wheatley, 1992; Senge, 1994; Zohar, 1997; Kilman, 2001; Shelton et al, 2003). The publication of Taylor's Principles of Scientific Management (1911), reinforced the idea that organizations should be managed according to scientific principles. Taylor's management philosophy was directly tied to the prevailing Newtonian worldview, to bring more 'predictability and control to the management of organizations … at the same time in France, Henri Fayol developed a set of management skills that further reinforced the Newtonian worldview. Fayol's management skills (planning, organizing, commanding, coordinating, and controlling) have been widely used for almost a hundred years' (Shelton et al, 2003: 353-361); Zohar, 1997) contends that a paradigm shift in the way we think is needed before we can change organizational models, and that this thinking is based in the Quantum realm of conscious participation, she contends that: '*Quantum thinking is the link between the brain's creativity, organizational transformation and leadership'* (Zohar, 1997: 21).

The quantum approach to modelling organizations sees organizational participants involved in continually re-designing processes and systems (Kilman, 2001) dynamically controlled through responsibility and alignment of values (Wheatley, 1999), taking into account the changes in the external environment. This paradigm relies on the internal active participation of people. Kilman (2001) sees these trusted participants as the enlightened people within current organizations, trusted with the ability to make fundamental decisions on behalf of the organization. This is aligned to Maslow's 'peak experiences' and therefore implies a spiritual context to personal values and meaning (Zohar et al, 2004). Kilman (2001: 52) further states that, in the past people have been trained and rewarded according to a Newtonian-Cartesian paradigm and have been changed into inert molar objects, controlled by external forces of reinforcement and coercion. Kilman (2001) continues that a shift in thinking to 'enlightened participants', will '*…generate quantum thinking, which is the basis for self-designing, implementing, and improving formal systems and value-added processes. As members enhance their innate capabilities for creativity, collaboration and commitment, they will perpetually transform themselves and their organizations*.' Intervention is required in assisting people to develop their self-aware consciousness to become self-motion monads within the organizational structure.

The basic premise of the economic motive for companies is to make profit, which aligned to Newtonian thinking, has created businesses that are focused on their own individual 'dimensions' of profit making, within a larger dimension of separated and fragmented supply chains, driven by shareholder value. Beyond the basic assumptions of capitalism there are unconscious assumptions 'each agent or corporation is an island unto itself whose actions have no unwanted consequences, and whose interests are under its own self control…without regard to or concern for wider issues' (Zohar, 1997).

The concern with a deterministic and one dimensional approach to organizational design, is that the values associated become 'selfish' (Zohar & Marshall, 2004) and lead to a continual search for more and more finite measures within the current system or paradigm leading to learning inefficiencies, as 'problems are addressed and errors are corrected using only past routines and present policies' (Robbins & De Cenzo (2008). Werman, (2000) states that; 'all along we had been trying to control the outcomes by forcing artificial structure and measures upon the discrete aspects of the plan'. Wheatley [70] translates Newtonian-Cartesian thinking into deterministic values within an organization, when she states that '*In organizations, we are very good at measuring activity. In fact, that is primarily what we do. Fractals suggest the futility of searching for even finer measures that concentrate on separate parts of the system. There is never a satisfying end to this reductionist search, never an end point where we finally know everything about even that one small part of the system*'

Values associated with measuring organizations from a quantum world view, suggests that the world operates within multiple dimensions and not linear ones telling us that the parts are not independent but dependent on the whole. All participants are connected therefore and that there is no space between them. Thus, suggesting a movement towards a holistic view of the organization, within its environment. As such, Heylighen (2008) states that a complex system cannot be separated into a set of independent elements; hence a reductionist methodology cannot be applied to the study of complex adaptive systems. To study perturbations to the system in context requires an understanding of sets or patterns within complex environments. The study of thermodynamics and fractal dynamics suggests a systems thinking approach where parts are dependent on the whole (Prigogine, (1998); Kauffman (1993); Mandelbrot in Heylighen (2008)). This system can in general be seen as a cyclically closed system of processes (self-organization). Thus, through understanding the metaphysical aspects, where the shift is to the conscious self-management of a flexibly designed organization within a multidimensional environment (Kilman [35]), the move away from a pure shareholder value system to an integrated value system, is in line with systems thinking and would include the entire value chain of participants having the same vision,

mission, aligned strategies and objectives, and measured by greater set of norms and values.

Fornaciari & Dean (2001), state that there is an emerging stream of research exploring aspects in organizations relating to collaboration and participation, and social scientists have started to give attention to religion and spirituality in organizations that opens up organizations to intelligences beyond IQ (intelligence quotient), and EQ (emotional quotient) to SQ (spiritual quotient), that move in dimensions beyond our limits of space and time. We believe this will move us into transcendental territory, which allows us to align both quantum physics (nuclear) and psychology of the unconscious (Jung, 1989). On the premise that innovation requires multiple dimensional perceptive thinking to envision new worldviews, SQ has wider implications for innovation within an organizational context, beyond forming the strange attractor of meaning between individuals and organizational outcomes.

4. Complexity in a Quantum Environment

There is no denying that the future world of work will be different. There are numerous signs of environmental changes, for instance, (1) *politics*: the threat of India and China as new world powers, and possible demise of Africa, the war on terror, the issue to secure oil and other resources and human rights violations; (2) *economic turbulence* caused by globalization and de-regulated markets and new technology; (3) *globalization and de-regulated markets* that will remove barriers, increase free trade, create more and more consumer choice (companies can no longer rely on regulations to protect their business, the most significant competitor will not come from current industry, governments are stripped of power and increase the power of the consumer); (4) *technology:* the decreasing price boom, raw material prices and commodities will fall and the computer and telecommunications industry have provided the platform for e-commerce; (5) *the knowledge economy*: primary resources have become far more intangible and difficult to contain. Knowledge and information have no value until it is used for a specific purpose; (6) global warming and sustainability (Copenhagen Diagnosis, 2009); international terrorism and piracy.

Greene (2004) believes that [quantum mechanics] is the *'The framework of laws governing the universe whose unfamiliar features such as uncertainty, quantum fluctuations, and wave-particle duality become most apparent on the microscopic scales of atoms and sub-nuclear particles.',* while Hawking (2002) famously proposed that *quantum mechanics does not predict a single definite result for an observation. Instead, it predicts a number of different possible outcomes & tells how likely each of these is. Thus, if one made the same measurement on a large number of similar systems, each of which started off in the same way, one would find that the result of the measurement would be A in a number of cases and B in a different number and so on*.'

We agree with Lewin & Regime (2001) who state that the science of complexity has to do with structure and order and not random chaos, especially in living systems such as social organizations, the development of the embryo, patterns of evolution, eco systems, business and nonprofit organizations and their interactions with the technological environment. It provides a more accurate view of reality. The role of complexity science (and complex adaptive systems) in business is well explained (Elliott, 1999). Simply defined, complex adaptive systems are composed of agents that interact with each other and, in doing so, generate new behaviours for the systems as a whole (Lewin & Regine, 2001). Moreover, the patterns of behaviour in these systems are not constant since, as the system's environment changes, so does the behaviour of its agents and, as a result, so does the behaviour of the system as a whole. Complexity science is the study of complex adaptive systems. A complex system is a system having multiple interacting components, of which the overall behavior cannot be inferred simply from the behavior of components. Complexity science spans scales from particle fields to information mechanics (physical analysis of the dynamics of information transmission) and adaptive systems (learning and consciousness, including neural systems), to human society, ecosystems and extraterrestrial space. These phenomena all share the qualities of a self-organizing network. From their study, new methodologies and concepts of the nature of reality have emerged. In international relations, the emergence of an interconnected global civilization manifests this sort of complexity. In knowledge creation, so do the cross-fertilization and merging of academic specializations into ever newer and more numerous interdisciplinary subfields (Cutler, 2010).

There are five primary principles to operate in a complex reality Lewin & Regine (2001). These are: (1) *agents interact and mutually affect each other in a system:* This focuses on relationships between and among people, teams and companies, (2) *agents' behaviours 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).

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.

Complexity allows a two tiered focus in business: (1) its performance system (responsible for the performance of current goals and tasks for immediate survival), and (2) 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 organizations should be robust in terms of both subsystems but tend to concentrate on only one (Robb [50]).

5. Structure and Linearity in Management

Twenty first century enterprises functioned in a relatively simple, stable and predictable environment. As a result, managers were able to make decisions based on intuition or by repeating procedures successfully used by other executives or used in the past. These methods did not always approach the problem systematically and did little to improve or advance the managerial decision making process. However, early examples of systematic approaches do exist. For example, in the fifteenth century, Venetian shipbuilders used an assembly line of sorts to outfit their vessels. In 1776, Adam Smith suggested a division of labour based on his analysis of straight pin manufacturing. And, in 1832, Charles Babbage, presented a number of concepts of industrial engineering, including a skill differential in wages. In the late 1800s, an American engineer named Frederick Taylor formally advocated the scientific approach to manufacturing. Using time studies, he analysed work methods, established standards and evaluated work performance. He believed there was one best or most efficient way to accomplish a task. Henry Gantt, a contemporary of Taylor's, extended these concepts by including human behavioural factors. In summary, these early scientific approaches were limited to establishing or improving efficient performances for specific tasks in the lower levels of organizations.

World War II created unprecedented problems in resource allocation, production planning and scheduling, inventory and quality control, transportation and logistics. Past procedures proved inadequate and the leaders recognised the need for analytical reasoning. Multidisciplinary teams (consisting of physical scientists, engineers, mathematicians and military leaders) were formed to study the problems and make the necessary recommendations. Since mathematics is the language of the scientific disciplines, the problems were formulated mathematically. Industrial applications spread in the 1950s with computer technology developing. Advances in computer technology provided the means to solve the more sophisticated mathematical tools. More so, sophisticated software programs were developed for standard techniques. The advent of computer based management information systems helped some of the data required by the procedures.

It is important to view any organism or phenomenon in terms of its parts and as a whole. This greatly assists in managing, controlling and optimising the entirety and its constituent processes. When attempting to sell the quantitative disciplines, most analysts do not consider political and monetary factors, or the personalities of the managers. Moreover, it is important to remember that an organization is a collection of interrelated parts (divisions, departments, machinery, people and so on) intended to accomplish specific objectives. As such, it constitutes a system. Hence, a decision in one part of the organization could significantly affect the operations of other segments. For example, an inventory problem within a firm's production department could disrupt marketing, finance, accounting and personnel functions. This calls for the systems approach, wherein a problem should be examined from the overall organizational point of view. This provides the key characteristic of management scientists. Furthermore the organization exists within the environment in which it operates. Hence the firm's actions may affect market, social and political conditions. Likewise, actions by unions, consumers,

competing firms and the government affect the organization's operations. Incorporation of these environmental factors into the analysis should hence be part of the systems approach.

Peter Senge's now classic, *The Fifth Discipline* (1995), provides a great understanding in terms of moving from individual parts to the sum of all parts to create total synergy. He maintains that a systems approach is the result of individual personal mastery (he says: '*I am my position*', i.e. to each of us rests the responsibility to take ownership of the part in society or in any structure that is allocated to us). If we all do this within the same entity or organization, there will be shared vision, shared meaning and eventually, a systems approach where the sum of the past is larger than the whole. Turning this upside down, it also means that changes in individual elements of a system, will influence the total system. We will return to systems thinking in the last chapter. Logical, is it not? Until we remind ourselves how often leadership or individuals change in an organization, but that same organizations still try to maintain its same values, beliefs and culture. If the individual elements change, the sum of the parts will be bigger than the whole, but a different whole. Make sense?

The past two decades has seen a radical shift in the basic foundations of how business is conducted. The globalization of markets and production resulted in national markets being integrated into a single global market trading in global products. The shift has been strengthened through the declining of trade barriers and fundamental developments in communication, information and transportation technologies. Globalization resulted in greater world output, foreign investment, greater imports and exports and immense competitive pressures both between nations and industries (Hitt, Ireland & Hoskisson, 2005); Pearce & Robinson, 2005). Advancements in information technology and related developments in communication technology has increased organizations' ability to link global operations into sophisticated information networks, shrinking the time in which information is collected and enabling organizations to achieve tight coordination in worldwide operations (Hitt, Ireland & Hoskisson, 2005; Laudon and Laudon, 2003 and Pearce & Robinson, 2005). External factors influence the organizations' direction, organizational structure and internal processes. These factors that exist in the organizations' remote, industry and operating environments require constant monitoring for the formulation of strategies to optimise the organizations market opportunities and threats to allow them to survive in their competitive environment (Pearce & Robinson, 2005).

All actions taken by organizations are intended to allow them to achieve strategic competitiveness and earn the organization above-average returns. Strategic Competitiveness is achieved by an organization when it successfully formulates and implements strategy which creates value. If competitors are unable to duplicate, or find the strategy too costly to imitate, the organization has achieved a sustainable competitive advantage (Hitt, et al., 2005). These authors are of the opinion that the fundamental nature of competition in many of the world's industries are changing, and the pace of this change is relentless and ever increasing. Conventional sources of competitive advantage are no longer effective, requiring managers to change their traditional mindset and adapt a new mindset which values flexibility, speed, innovation, integration, and the challenges that evolve from the constantly changing conditions (Hitt et al., 2005).

Organizations are aware that the rigid, seldom repeated review of organizational strategy is no longer feasible to achieve competitive advantage. Ideas and mindsets that were prominent five years ago could now be archaic, requiring a rethink of organizational strategy on a more frequent basis. The pace of change and reform has increased the speed at which organizations are required to define strategy, but has not removed the need for a structured strategic management process. Strategic Management is an integral part of the running of an organization, but require strategic decisions to be based on valid, and actionable intelligence, rather than the ideals, on which the organizations visions are based.

In the modern management environment, there are numerous examples of our focus on relationships and networking. Social networking sites like Twitter, Facebook, LinkedIn and Google Buzz; and search engines like Google, Bing, and the new natural language processing focusing on the comprehensiveness, accessibility, relevance and speed of information. The standard management theories are mostly based on a linear environment and provide linear solutions for the linear problems identified. For example, Table 3 summarises the extant management models indicating their application and evolution.

[INSERT TABLE 3 HERE]

6. Linear Decision-Making Process in Management

Simon (1987) originally identified a systematic decision-making process involving three major phases: intelligence, design, and choice. Simon later included an implementation phase, while Turban, Aronson, Liang & Sharda (2007) suggest a fifth phase which includes monitoring and feedback (Turban, et al., 2007). Robbins & De Cenzo (2008) identify the steps within the decision-making process as including identifying the problem,

selecting a solution, and evaluating the effectiveness of the solution. They further identify a single problem as a discrepancy between two states, the existing state and the desired state of affairs. Furthermore, once the problem has been defined, decision criteria are to be identified. These decision criteria are factors that are relevant in the decision making process and could eliminate certain courses of action. The criteria are then weighted and the best outcome selected and implemented. The final step in their model includes the evaluation of the results to appraise whether or not their decision corrected the problem (Robbins & De Cenzo, 2008). Simon's model is seen to be the most concise and complete characterisation of rational decision-making. The model includes a continuous flow of activity originating at the intelligence phase moving through design to choice to implementation while a return to the previous phase is possible (Turban, et al., 2007).

[INSERT FIGURE 3 HERE]

The decision-making process begins with the intelligence phase, during which the decision-maker examines reality which identifies and defines problems. During the design phase, a model that represents the system is constructed by making assumptions which simplify reality, and identify of all relationships among the variables. The proposed model is validated and criteria evaluated which leads to alternative sources of action. The choice phase includes the selection of a proposed solution to the model, which is then tested to determine its validity (Turban, et al., 2007).

A major characteristic of decision-making is the use of a model, on which to analyse the effects of a decision on a model of reality rather than on the real system. Turban et al. (2007) define a model as 'a simplified representation or abstraction of reality.' Models represent systems or problems utilising different degrees of abstraction. These authors classify models based on their degree of abstraction (Turban et al., 2007):

- Iconic (scale) models are the least abstract models. They are physical replicas of the system, but on a smaller scale than the original. An iconic model can be either three dimensional, such as a model of a bridge, or two dimensional, like a photograph.
- Analogue models act like the real system but do not look like it. It is a symbolic representation of reality, and is most often two dimensional charts or diagrams. Examples include blue prints, organizational charts, animations, videos and movies.
- Mental models are descriptive representations of decision-making situations that people form in their heads and think about. The individual's thought process works through the different scenarios to consider the feasibility and risks involved in each potential alternative.
- Mathematical models are utilised due to the complexity of relationships in organised systems which cannot be represented by iconic or analogue models.

The advances in computer technology have increased the use of both iconic and analogue models in conjunction with mathematical modelling. Combined, the models allow for easy manipulation, the compression of time, reduced cost, inclusion of uncertainty factors, enhance learning and training, most commonly through a web interface (Turban, et al., 2007). They maintain that, when the proposed solution is found to be viable, the process moves onto the implementation phase. Successful implementation would result in the solving of the real problem, while failure will lead to a return to the earlier phases of the process. While the understanding of the decision-making process and the models that can be generated are critical components of decision-making within the management function, the foundation underlying organizational decision-making is the acquisition and use of information, intelligence and knowledge.

7. Resilience Engineering in a Complex System

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, 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 [33]). 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.

We like Johnson & Lenz's (2009) list of activities relating to resilient organizations. These are:

i. *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.

ii. *Resilient organizations prepare themselves and their employees for disruptions.* Attentive 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.

iii. *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.

iv. 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.

v. *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.

vi. *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.

vii. 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, for example,

'crowdsourcing' to engage people externally in solving a given problem or Eli Lilly's Innocentive Open Innovation Marketplace.

viii. *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.

To say that resilience is well-defined is not say that the work is finished. There is still much to be learned to accomplish the goals of resilience. Areas of major research include, but are not limited to, the application of resilience in both political and economic environments.

8. Making Organizational and Management Innovation Possible

Increasing global instability and competitiveness impose the compelling need to identify new paradigms, methods, applications and technologies to support renewal and creativity. In order to operationalize innovation, organisms (e.g. organization, entity or individual) should behave differently. The right hand column (table 2) embraces newness, renewal and develops a consciousness for them. There is more than talk and planning. There is energy and dialogue. The consequences are that the need for change unavoidably grows. Thus, the fundamental nature and soul of the organic organism should be transformed to make change the norm and accept this (change) as practice. These organizations could typically behave according to the following patterns: (1) employees collectively determine the direction and subsequently empower leadership to point the way, (2) leadership could help (collaborative) teams to realise they are off course and assist in the realignment within the whole, (3) frontline employees would be responsible for the movement of the organization, not the managers s and relationships become flexible and quickly adaptable. Thus innovation needs to happen at an organizational/management/technological level within a growingly unstable and unpredictable environment.

[INSERT FIGURE 4 HERE]

However we may make out that modern organic organisms (see how we defined them above) operate like this, the truth is that they remain hierarchical as the only way to retain control/order. This inhibits the creative space for organizational and management innovation as innovation takes place in an atmosphere of quantum thinking and thus requires resilience.

Organizations at the edge of chaos (i.e. where there is bounded instability), is the place for creativity and change, leading to innovation within organizations. This takes fundamental trust in the thinking ability of 'self-motion monads' (people within an organizational context). Such a thinking ability takes into account leaders as 'being'. Jung maintained that attaining balance within the psyche established wholeness within the individual, he further stated that, 'individuation means becoming a single, homogeneous (sic) being.' (De Charon, 2003). This has a correlation to the quantum skills model of Shelton et al. (1999), where the quantum skills are developed around a central tenant of being and supported by Kilman (2001) and Wheatley (1999), which is based on a chaos theory metaphor of fractals forming around a strange attractor, this strange attractor in an organizational sense, as per Wheatley (1999), is meaning or in this context 'being' and is the central link between the intelligence types of IQ, EQ and SQ as per Zohar & Marshall's (2004) work based on Maslow's hierarchy of needs. This finding supports a systems view of the world as per a quantum paradigm and a quantum leadership propositions. Such management will lead organizational participants in developing individual creativity utilising their knowledge and technology and linking of these to add greater value to the world around them, thus becoming self-transcendent and ultimately driving dynamic innovative strategies in line with a continually changing environment.

Resilience engineering (as in figure 4) allows for two juxtaposed views of management and thereby allows for (1) the generation of conceptualisation (alternative ways to understand and define a problem or opportunity), (2) optimisation (alternative ways to get an idea to work in practice and uncovering all factors to successful implementation), (3) generation (new opportunities and problems that can be capitalized on) and (4) implementation (new actions and results to gain acceptance of a new idea) of options in order to implement organizational/management/technological innovation. While this is being done, we will think about the really important question of what lies beyond innovation (other than more real innovation) if anything. And we think it might have to do with creativity and resilience in order to become globally competitive.

That great source of wisdom (Douglas Adams, 1980) said that

'*There is a theory that states that if ever anyone discovers exactly what the Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable. There is another theory that states that that has already happened.'*

And maybe that is how the world of complexity is.

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Table 1. Newtonian and quantum physics principles

NEWTONIAN PHYSICS	QUANTUM PHYSICS
The dualistic separation of consciousness and matter	The monastic unification of consciousness with matter
The universe as the motion of inert molar objects	Universes as materialised by conscious participation
The space between molar objects as flat and empty	Space/time as curved and filled with matter and energy
The unique existence of only one absolute universe	The existence of many relativistic universes
The deterministic certainty of inert molar objects	The probabilistic uncertainty among self-motion monads
The fundamental separation of inert molar objects	The eternal connections between self-motion monads
The eventual death of the one absolute universe.	The eternal self-organization of relativistic universes.

Table 2. Newtonian and quantum thinking principles

NEWTONIAN THINKING (ON)	QUANTUM THINKING (ON/OFF)
The exclusion of consciousness in the design of formal systems	The inclusion of consciousness in self-designing systems
The organization as passive jobholders following official procedures	Organizations as conscious participants in self-designing processes
The white space between passive jobholders as implicitly ignored	Cross-boundary processes as explicitly addressed and infused with information
The unconscious administration of a rigidly structured organization	The conscious self-management of a flexibly designed organization
The external control of passive jobholders	The internal commitment of active participants
The enforced segregation of passive jobholders	The empowered relations among active participants
The eventual self-destruction of a rigidly structured organization.	The eternal self-transformation or self-destruction of flexibly designed organizations.

Table 3. Summary of evolution of the management 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 Modelling System Dynamics Systems Engineering Engineering Logistic, 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, Organisational Learning	Hammer, Davenport, Martin, Senge, Goldratt, Porter, Prahalad, Hamel	Transformation of various governments New world order New socio-economic problems Dominance of IT sector
Complexity (2000+)	Complex adaptive systems Non-linearity Collaboration Resilience Innovation	Emerging	Networked environment Networked Pattern seeking Follows questions Technology is intrinsic Business as an organic collective

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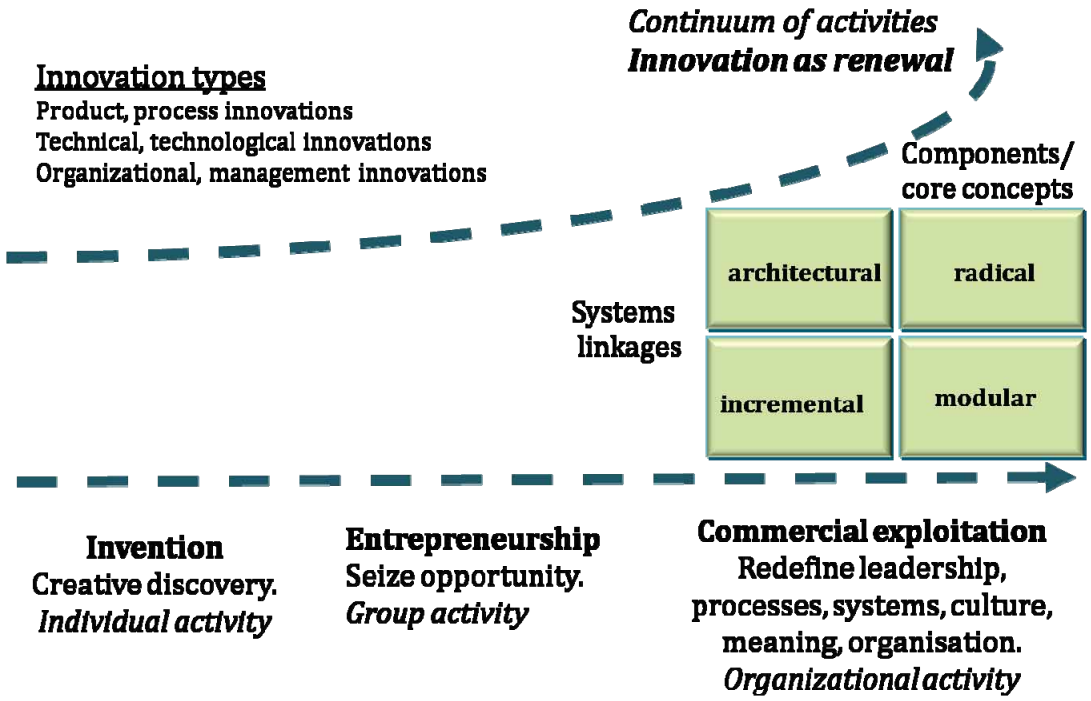


Figure 1. Innovation as a continuum of activities

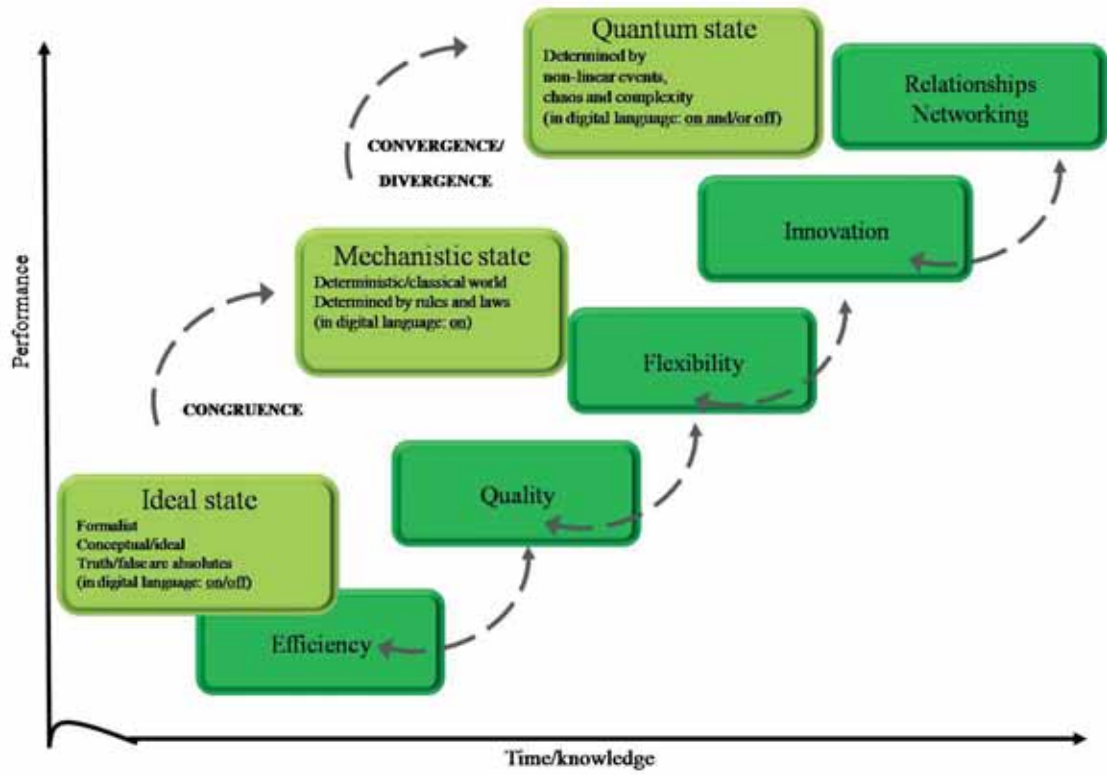
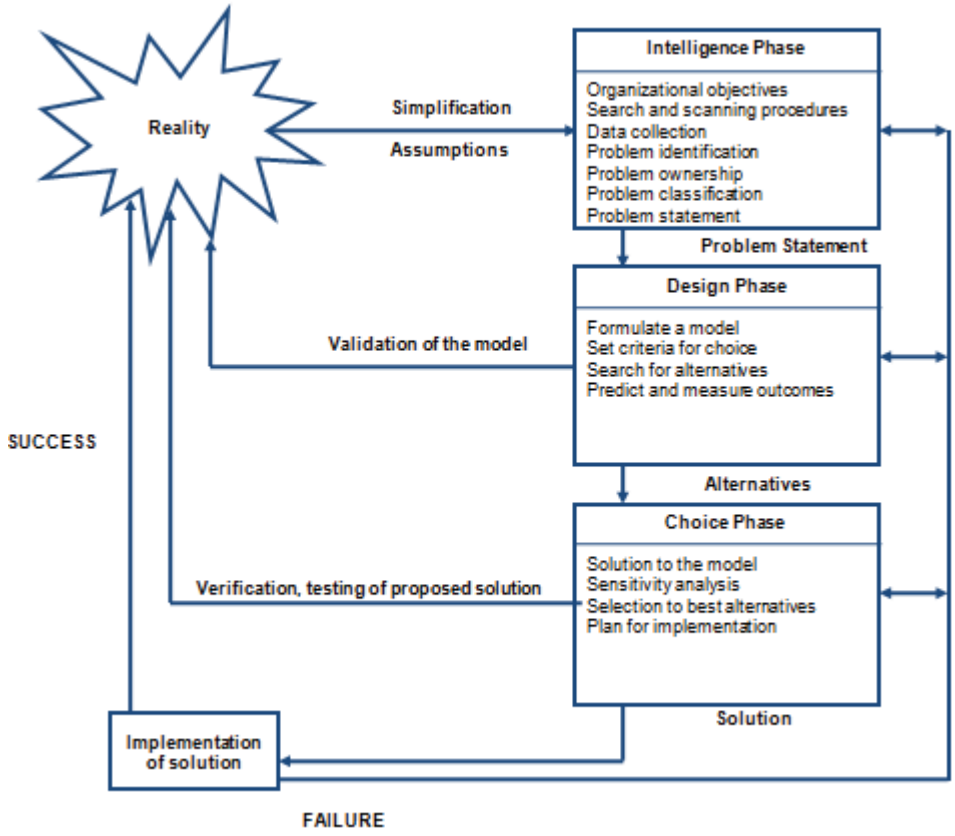


Figure 2. Changes in management thinking



Source: Turban et al. (2007:54)

Figure 3. The decision-making process

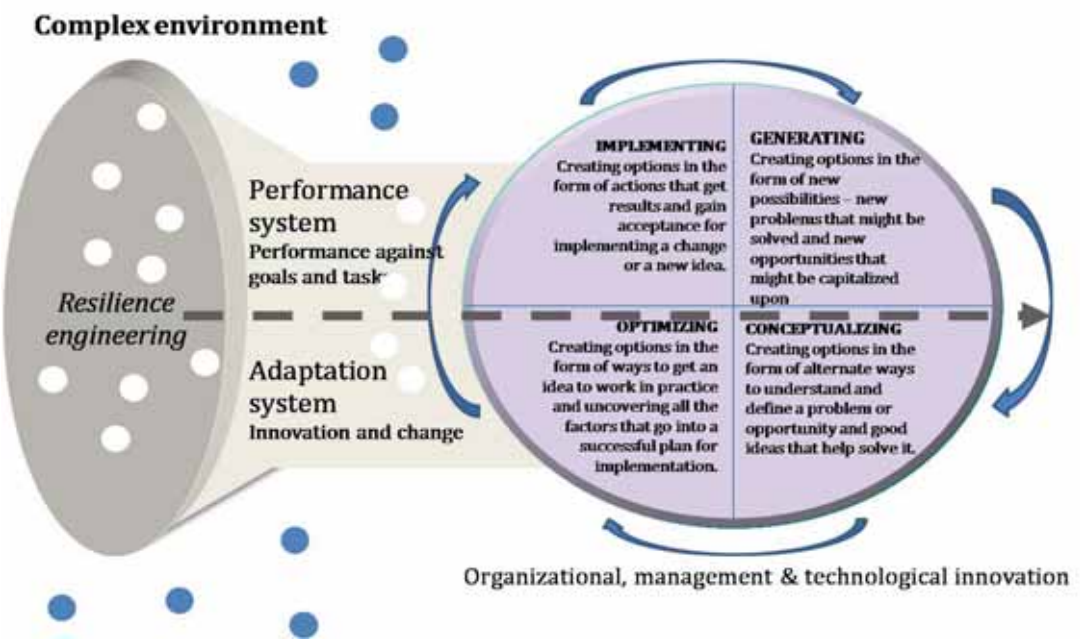


Figure 4. Resilience engineering to enhance organizational, management and technological innovation

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