COMPLEXITY MANAGEMENT A NEW APPROACH FOR A GLOBAL WORLD

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Abstract

The age of globalization needs first and foremost a mindset that is capable to understand its dynamics. A linear approach, such as traditional Newtonian-based strategy schools, to a non-linear phenomenon, such as our global world, leads to flawed results. This paper proposes that in order to cope with the dynamics of globalization, there is a need to shift from the old Newtonian paradigm that assumes linearity and predictability, to a complexity paradigm that emphasizes non-linearity, self-organization, emergence and holism. The paper further outlines some of the complexity implications to organization management.

Introduction:

The purpose of this paper is to present a new approach in the management of organizations, which has emerged as a result of recent developments in the physical and biology sciences. This approach is often referred to as Complexity Theory. The paper argues that organizations operating in a complex, globalized world need a complexity-based approach to make sense of their reality and their environment, often characterized by diversity, fast-change, and often unpredictability.

The paper first introduces some features of globalization which have made of our world a complex one. Then it contrasts the old Newtonian worldview with the precepts of complexity theory. After explaining the major principles of complexity, the paper sheds light on the implications of such perspective on organization management and the new role to be assumed by manager and leaders in organizations operating in a global world.

A New World with Old Paradigms:

The early 90s witnessed the birth of a new era (Hobsbawm, 1999). The Soviet Union collapsed and the Western business interests grew more and more. Information technology has created a world more networked and interlinked than ever before. International trade and air freight have witnesses an unprecedented boom. Laptops and mobile phones are making contact and communication much easier and quicker.

The purpose of globalization is to globalize the entire world economy. Information technology is making the globalization process so fast that "*small amounts of actual capital can be leverage to create large deals with many interlocking variables, each affecting the rest. These transactions are of such intricacy that in many cases they are not fully understood by the companies that promote them."* (Brown, 1997, p. 107).

Globalization is not without its evils. For many critics, the gap between the rich and the poor is becoming even wider. The promised higher standards of living are yet to be seen. Third world countries have to adapt to new rules to qualify and cope with the superpowers. (Chomsky, 1994, 1996, 1997; Hirst and Thompson, 1996).

To be able to make better sense of such a world, and manage organizations that operate in such environment, managers and decision makers need to make use of appropriate paradigms with tools capable to capture the reality of our world in a better and more accurate way.

The old-age Newtonian worldview implied a particular ontology through which the world is interpreted. *"For three centuries science has successfully uncovered many of the workings of the universe, armed with the mathematics of Newton and Leibniz,"* (Lewin, 199, p. 11). For the last three centuries, the laws of motion and other linear, mechanical principles influenced the history of Western thought from education, cultural studies, linguistics, and other social science studies. Through the Newtonian ontology, the world is seen as a clock, where actions are repetitive and predictable in a linear way. The reductionist assumptions of the world could not uncover the complexity and interdependency of the emergent behaviour of complex, nonlinear systems.

Another worldview, modeled after the Newtonian paradigm, has equally dominated the world thinking. This is known as Cartesian reductionism, which is built on the machine metaphor whereby the body is a biological machine and the mind is something apart from the body, what is now known as Cartesian dualism. A machine is built up from several small parts and to understand the machine behaviour, it can be divided into those small parts without affecting the overall character of the machine.

Newtonianism therefore is a formalism through which the natural system is represented for centuries. Cartesian reductionism obviously is not compatible with the nature of complex systems; it reduces the naturally complex to simple mechanisms. Robert G. Hagstrom (1999) comments that the Newtonian framework does not allow us to see the world as it really behaves in its richness.

Newtonianism is based on linearity whereby any changes in the output of a system are proportional to changes in input. For every effect, there is a specific cause. And to understand a system's behaviour, we need to reduce it to its components or parts and examine them separately (reductionism). The universe, according to Newtonianism, works in perfect order like a complicated machine.

For organizations managed by a Newtonian mindset, managing people can most efficiently be done by organizing them into well defined structures, by establishing policies and procedures, and by exercising control with clear directions. In such organizations, decisions are centralized and hierarchized. Lines of authority result in information flow from the top to the bottom. They also restrict the limits among the organizational levels.

The basic assumption of a Newtonian-based approach is that the environment is stable. The management's role is to maintain equilibrium between the organization and its environment. In order to meet future challenges, specific strategies are established where future changes are assumed predictable. In such organizations, managers are risk-averse and rely on tight formal control to keep things in stability.

Organization management based on Newtonianism cannot cope with a networked world where the output is never proportional to the input, change is growing faster and faster, and what happens the next day is hardly predictable.

A New Paradigm for the New World

Research in complex systems, or complexity theory as it is often called, is a way of looking at the world. It has profound epistemological and ontological implications. It helps explain a wide range of phenomena from hurricanes to stock markets, from biological systems to chemical, physical, and economical systems. All these systems are composed of many "agents" acting in parallel. They all exist in environments that are produced by the interactions of other agents. They are engaged in a continual process of reaction to what other agents in the overall system are doing, and thus the environment is always in flux, never standstill. Any system is a group of a number of parts which interact to function as a whole. The root word *systema* means "organized whole." The parts of a system are intricately interconnected and interdependent. Every system is composed of subsystems and is nested within larger systems.

In complex systems, linear, top-down, mechanistic analysis is unable to provide an accurate description of the behaviour of the complex interactions among agents and how higher levels of complexity emerge. The interactions among agents do not happen under predictable laws or set rules. As Gell-Mann (1994) puts it: "*Scientists ... are trying hard to understand the ways in which structures arise without the imposition of special requirements from outside. In an astonishing variety of contexts, apparently complex behaviors arise from systems characterized by simple rules. These systems are said to be self-organized and their properties to be emergent."* (pp. 99-100).

The real world is made up of complex systems. The alternative ontology that complexity offers is that when a system is reduced to its parts, the whole loses its meaning and identity. With complexity, the whole is more than the sum of its parts. When the parts interact, there is a third effect that is born, a synergy that the whole system displays. *The American Heritage Dictionary* (1991) defines synergy in these words: "1: The interaction of two or more agents or forces so that their combined effect is greater than the sum of their individual effects; 2: Cooperative interaction among groups, especially among the acquired subsidiaries or merged parts of a corporation, that creates an enhanced combined effect [from Greek sunergia, cooperation, and from sunergos, working together]."

Complex systems are therefore indivisible, for in their wholeness lie important systemic characteristics. The complexity of these systems is irreducible to their constituent parts. This complex behaviour is basically emergent. It is not possible to understand a complex behavior's integrity by analyzing the system's components (West, 1985; Thelan and Smith, 1994). Holland (1995) calls emergence an aggregation process by which he means the *"emergence of complex large-scale behaviors from the aggregate interactions of less complex agents."* (p. 11) Complex phenomena are everywhere around us. When birds are engaged in their flight, they display complex patterns, and so do all other life forms in the entire ecosystem. Human communities are composed of complex patterns of interactions, which are in essence non-linear and unpredictable.

Despite the varied terminology used in complexity research, there are some useful definitions and some common characteristics of complex systems, which suggest homogeneity in the current literature on complexity thinking. Waldrop (1992) defines a complex system as follows: "*... a system that is complex, in the sense that a great many independent agents are interacting with each other in a great many ways."* (p. 11). Bar-Yam (1997) suggests that *"...to understand the behavior of a complex system we must understand not only the behavior of the parts but how they act together to form the wholes."* (p. 1). This wholeness of a

complex system and the impossibility to understand it by reducing it to its parts is further emphasized by Kauffman (1996) who maintains that *"…the complex whole may exhibit properties that are not readily explained by understanding its parts. The complex whole, in a completely non-mystical sense, can often exhibit collective properties, "emergent" features that are lawful in their own right."* (vii-viii). So the complexity of a system is distributed across the system. Viennese biologist Ludwig von Bertalafanny believed that all living systems are complex; they have certain characteristics in common, and his book "General Systems Theory" is one of the primary sources for complexity research today.

For Cilliers (1998) the essence of complexity in a system permeates every level: *"complexity is not located at a specific, identifiable site in a system. Because complexity results from the interactions between the components of a system, complexity is manifested at the level of the system itself. There is neither something at a level below (a source), not at a level above (a meta-description), capable of capturing the essence of complexity."* (pp. 2-3).

Complexity emerges out of simple agents governed by simple rules. In their interactions lies the source of the complexification process, as Stephen Wolfram puts it "*...you generally find that the basic laws are quite simple; the complexity arises because you have a great many of these simple components interacting simultaneously. The complexity is actually in the organization, the myriad possible ways that the components of the system can interact."* (Quoted in Waldrop, 1993, p.86).

So the system's complexity emerges from within spontaneously. This process is referred to in complexity literature as self-organization. Complex systems are capable to generate their own order and patterns, *"something out of nothing."* (Goodwin, 1994), *"order for free"* (Kauffman, 1993): *"First of all, contrary to our deepest intuitions, massively disordered systems can spontaneously "crystallize" a very high degree of order. Much of the order we see in organisms may be a direct result not of natural selection, but of the natural order selection was privileged to act on. Second selection achieves complex systems capable of adaptation, but of the natural. Moreover, I shall suggest that there are general principles characterizing complex systems to adapt. They achieve a "poised" state near the boundary between order and chaos, a state which optimizes the complexity of tasks the systems can perform and simultaneously optimizes evolvability."* (p. 173).

Out of the vast literature on the behaviour of complex systems, one can summarize their characteristics in the following points:

- In complex systems, small inputs can lead to large consequences.
- Slight differences in initial conditions produce different outcomes. So any small change in the beginning state of a system may change the system outcome. This extreme sensitivity to initial conditions is referred to as the butterfly effect. It is now considered a scientific fact that the flap of a butterfly wing in Jeddah may result in a weather change in Dhahran.
- System-wide properties emerge from aggregate behaviour of individual parts.
- Complex systems interact with their environment, learn from it and adapt to it. Behaviour that may appear random has deep, underlying patterns.

- Complex systems move toward states to which they eventually settle. These called attractors. Organizations have attractors they settle to but the environment may change, causing the organization to change. Resistance to change leads organizations to become obsolete. Continuous learning helps them adapt to change and survive.

- The effects in complex organizations are rarely proportional to causes. Relationships among the variables are non-linear.

- Complex systems influence and are influenced by their environments through feedback mechanisms. Systems use feedback by using their own outputs to adjust their new inputs.

- Complex systems are self-organizing. Order and coherence is not imposed from outside. Their dynamics emerges spontaneously from within their structure. When a complex system is open to its environment, it may be pushed to a state far from equilibrium. In such case, thanks to its ability to adapt and learn, it spontaneously reorganizes itself into a new structure. This phenomenon is called self-organization. The new structure occurs spontaneously from the emergent behavior of the whole system.

- Individual parts of complex systems influence each other's behavior. This is called coupling. There are three levels of coupling: tight coupling when the system parts have a great influence on each other; loose coupling when the influence is not strong; uncoupling when none of the parts influences the other. The change rate and magnitude are affected by the level of coupling in a system.

Implications of Complexity to Organization Management in a Global World.

Many organization theorists and practitioners are borrowing insights from complexity concepts and principles, in order to cope more effectively with the challenges and rapid change in contemporary organization life. In 1999, Michael Lissack and Hugh Gung edited a volume titled *Managing Complexity in Organizations: A View in Many Organizations*. This edited collection testifies to the wide range of applications of complexity thinking in many areas of management theory and practice. The participants in the volume have agreed that complexity thinking provide new metaphors for thinking about organizations, and new models for sense-making in organizations. People, according to these authors, look for meaning and complexity thinking helps achieve it through an emphasis on the power of interactions and relationships that capture their intentional quest for coherence. Out of the network of self-organizing interactions, coherence emerges.

Glenda Eoyang (1997) calls our world "not only uncharted; it is unchartable. Like a shifting sand dune, it evolves from moment in surprising and unpredictable ways. Any attempt to freeze and explain a current state is destined to fail because at the next moment a new reality will emerge, which might bear little resemblance to any previous state." (p. 5). However, she points out that linear predictability and complex adaptation are not mutually exclusive. There are some aspects of our organizations that can be structures and predictable while others are complex and unpredictable. The manager's role is to sense his/her organization and decide which best tools solve which problems.

R. Lewin and B. Regine (2000) argue convincingly that the old mechanistic, command and control workplace model has outlived its purpose. Industry is undergoing continuous evolutionary changes, and companies must see themselves as complex adaptive systems more

like environmental ecosystems. Their survey of a number of companies in both the United States and England has shown how businesses embracing complexity thinking have achieved improved profits and a more humane workplace.

Dana Zohar (1997) provides us with a set of new metaphors that help managers view their organizations as organisms capable to adapt to internal information and external environment, to embrace uncertainty and chaos and thrive on them, and to relinquish command and control. Purpose drives the self-organization process continuously from a lower to a higher level of order. For Zohar, managing complex organizations through half-plans, on the edge of chaos, is very compatible with human nature, how the mind and the brain function.

Irene Sanders (1998) argues that complexity theory has the advantage of providing us with insights into the dynamics of the real world and how change processes unfold. For Sanders, the concept of sensitivity to initial conditions is a powerful one as it helps us develop insight into the present and foresight into the future. In setting up strategies for organizations as complex systems, especially in an age of globalization, seven principles, as defined by the new science, need to be taken into account namely, looking at systems as wholes not as parts; the interaction between order and disorder leads to self-organizing change; a change in one part of the system causes turbulence in another; visual images help us see connections and patterns of interactions; scanning external environment helps us see emerging conditions; non-linear thinking is critical to understanding changes in the environment; and finally perspective is important when viewing chaotic events.

For Wheatley (1999), a new way of organizing is needed for our quantum age where at the subatomic level, there exists not "things" but only "relationships", and where order and chaos are seen as mirror images. She encourages managers and organization members to rethink long-held notions that disruption and confusion are negative. It is only through them that creativity is awakened. For in dissipative structures, new information helps the system self-organize to a higher level of complexity whereby it is more capable to deal with the new situation through its capacity to adapt.

Managers are progressively finding a new vocabulary to describe the reality of their daily life at work. Old metaphors are giving way to new ones. Old assumptions about causal relationships in organizations are being reexamined. Complexity concepts are quickly becoming attractive because they are seen to be able to provide a more accurate view of reality, and a more effective way to manage people in a complex, interconnected environment, characterized by globalization and unpredictability.

The notion of control in organizations for instance has witnessed a major shift. In complex organizations, control is highly distributed. Agents have each only a partial view of the total view of the organization; they all engage themselves in networks of interactions, but the behaviour of the whole organization cannot be understood by investigating those individual agents. In a complex adaptive system, the whole is greater than the sum of the parts. Everyone contributes but no one has any idea who exactly has caused a particular pattern or trend.

Agents in complex organizations accumulate learning and experience; the new learning helps them adapt to changes in environment. Learning at the organizational level facilitates the evolution of organization to higher behavioural patterns. This requires a lot of shared information in a form which is easily accessible to everyone. Tight coupling among the organization members influences the level and speed of information transfer and the change

process effectiveness. In this way, organizations become complex adaptive systems. As such, the agents' behaviour is constantly changing; they are continuously learning and reacting. Complex organizations are never at rest, for stability is equivalent to death.

Feedback, within the organization and outside it, usually taking the form of new information is important for an organization to be able to adapt to its changing environment.

In organizations seen as complex adaptive systems, small changes have ripple effects throughout the system and can transform the system as a whole. For the behaviour of the whole emerges out of the relationships between its parts, and when the parts change, then the whole may alter its behaviour patterns. The managers' role is to lead change by embracing a variety of possibilities because every member's view counts. The solutions that work best are the ones to be adopted and thus become the property of the whole organization.

The managers' role is to focus on fostering relationships, thus creating a suitable space for people to mutually affect each other. They can engage in teams and learn from each other, allowing novel ideas to emerge from the lower reaches of the organization rather than to dictate them from on high. (Richard Koch, 2000). The managers' role is to create conditions for the emergence of constructive relationships in their organizations; they should cease to plan strategic objectives in detail with accurate design. They should let their organizations naturally evolve, and learn how to go with the flow.

Emergence is the key ingredient that makes a system complex. The emergent behaviors and characteristics in complex organizations are different from the behaviors and characteristics of the individual members. The organization's culture emerges from individual behaviors. Organization members shape the organization and the organization in turn shapes them in a continuous feedback loop. The emergent behaviour patterns are the source of creativity and innovation. It is a new phenomenon arising in a system that wasn't in the system before.

Complexity concepts have given birth to a new interest in the importance of relationships in organizations. "Management guided by the principles of complexity science therefore constitutes a style that is very human-oriented in that it recognizes that relationships are the bottom line of business, and that creativity, culture, and productivity emerge from these interactions." (Lewin, 1999, p. 203). Relationships in complex organizations breed better and continuous communication, which in turn leads to stronger connections. Free-flowing communication and caring relationships act like a central nervous system for the organization. Relationships across nations have the same value for the development of all.

Members in complex organizations interact and have a natural tendency to self-organize through their interdependence to achieve their shared goals. They affect each other and are capable of a high degree of creativity and innovation which cannot be precisely predicted. This implies for managers a new mindset that should allow enough freedom to let teams work out their agendas and decide how to implement them.

Conclusion:

This paper argued that for a globalized age, where a small change in one part of the world has tremendous ripple effects in another, a new paradigm is needed. The old, Newtonian paradigm is no longer able to make sense of the reality of the world. Through its reductionism and linear causality, it has failed to provide an accurate analysis of a world that is essentially complex. For organizations in a globalized world to better make sense of their

situations and survive, complexity theory has the potential to provide a framework and a set of metaphors that capture the reality of the world in its diversity, vibrance, and unpredictability. It helps managers appreciate the complexity of their organizations instead of resisting it. In this way, they become at home with their organizations.

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Top