Exploring Organizational Complexity to Increase Quality, Productivity and Innovation Performance for Total Excellence

KOSTAS N. DERVITSIOTIS

Member IAQ, Professor Emeritus

Department of Business Administration, University of Piraeus, Greece

ABSTRACT

Leaders worldwide who are intensely concerned about fast-changing conditions in their environment keep asking: "what is our organization to do in our turbulent times, in order to survive and sustain profitability?". The fundamentals of business success remain the same: (1) Keep customers satisfied with top product quality and service, (2) Offer products at a competitive price and (3) always aim to anticipate customers' emerging needs with new better products and processes. The first challenge requires faithful implementation of the principles of quality management to satisfy customers, employees and other stakeholders. The second challenge involves making the best use of needed resources, i.e. increasing the productivity of people, materials and capital assets, minimizing waste through the use of lean systems. The third challenge requires the cultivation of an organizational culture that can innovate on products, processes and business models, based on anticipated customer needs through effective conversations and feedback loops with customers, non-customers, employees, suppliers and others.

In a continually evolving global market with extensive interdependence among participants, it is inevitable for private and public organizations to encounter increasing complexity, combined with increased volatility and uncertainty. Such developments make it more difficult to identify on time the ensuing opportunities and threats that will allow the development and implementation of an effective strategy.

It is imperative for leadership to understand and cope with emerging complexity both inside and outside the organization, so as to maintain a suitable level of flexibility in responding to change. In this paper we review briefly the sources and variety of organizational complexity and the variety and methods available for attaining a more viable balance to cope with oncoming new challenges.

Keywords: Organizational complexity-gap challenge, strategic versus operational complexity domains, multiple-level conversations-for-action, intervention points for performance improvements, innovation-based adaptation for success.

INTRODUCTION

At each stage of its development an organization is confronted with a level of complexity determined by its degree of maturity and fitness with its environment. On one hand leadership must cope with developments in the external environment driven by advances in technology, changes in the global economy and demographics, along with less predictable geopolitical events, such as the conflicts in Syria, Ukraine and other parts of the world. On the other hand leadership and managers at all levels and employees must deal all the time with issues of internal complexity related to the operation of the three basic kinds of processes, i.e. materials transformation, information processing and human communications, found in all organizations.

In the 2010 Global CEO study released by IBM (the 4th biennial study since 2004), complexity was identified as the greatest challenge for leadership, as determined from 1500 face-to-face interviews with private sectors CEO's (80%) and senior public sector leaders (20%) from 33 different industries in over sixty countries. This was the first time complexity was at the top of their agenda, compared with the challenge of change identified in the previous three surveys. The above survey defined the concept of *complexity gap* as the difference between expected complexity and the extent to which CEO's believed they were prepared to manage it. Of the total surveyed, 80% of the CEO's expect the business environment to become more complex in the future, while less than 50% admitted they were prepared to manage it. The survey grouped the companies in the sample in (1) stand-out companies, (2) average and (3) poor, reporting a complexity gap of 6% for stand-out firms, 30% for the average and 52% for the poor ones. For the stand-out firms complexity was perceived as a source of opportunities while average and poor firms saw it as a threat (IBM Survey, 2010).

Leadership can address issues arising from complexity only through a better understanding of how complexity arises in day-to-day operations and in longer-term impacts from changes in its environment (customers, suppliers, competitors and others). *At the most basic level complexity derives from an organization's internal and external environment, defined and described by networks of active relationships* (Barabasi, 2002; Buchanan, 2002). Adding new global suppliers or a production facility in another country to meet increasing global demand introduces additional complexity from new production or storage facilities, as *new network nodes*. Furthermore, adding new supply chains and new communication introduces new network links. The level of complexity encountered by a firm rises rapidly with the number of relationships in both its internal and external networks.

EVOLUTION OF COMPLEX LIVING SYSTEMS

It is important to distinguish certain basic kinds of systems in terms of the degree of management difficulty. *Mundane systems* are the easiest to deal with as their operation demands little effort, the key issues addressed in their design. Next we have *complicated systems*, such as a government tax agency or a multi-thousand item inventory system, in which the number of system parts may be very large but their management is straightforward based on well defined rules. Finally, we have *complex systems* in which the difficulty in their management stems from the relationships among the system parts, growing exponentially with the number of parts. These systems present the greatest challenge as their behavior is affected by the presence of uncertainty and turbulence in their environment, especially for human social systems we regard as living systems that change with time to adapt to emerging conditions (Dervitsiotis, 2013).

In living organizations increased complexity leads to changes along two dimensions :
 1. *System Differentiation*. This measures the number of parts that comprise the system and the functions that these perform. A multinational firm operating globally is more differentiated than another operating domestically. An increase in the number of parts and functions enables an organization to increase its repertoire of responses to environmental changes. This is done by restructuring to have more system parts (more company units, plants, etc.) and more effective interactions among its parts.
 2. *System Integration*. This describes the degree of communication and coordination among the parts and functions of a system. Using a modern IT network enables staff to communicate and coordinate better in responding to orders and external changes. An increase in the system parts coordination capability enables better integration and improved connectivity of its parts for faster and more efficient responses to environmental changes. Progress in a system's evolution can be measured by the system complexity

achieved. Complexity in this context is described by the above two dimensions of change, i.e. system differentiation and system integration, which alternate in a step-function as a system evolves to more advanced forms:

The most effective approach to understand complex systems is that of "systems thinking", based on their key properties of : 1. *Interdependence,* 2. *Seeing Wholes* rather than parts and *Patterns* rather than events, 3. *Seeing self-organization of living systems,* 4. *Recognizing emergent properties at each level of organization* that do not exist in systems at lower levels (Senge, 1990; Conti, 2009). At each level a system is created by systems of lower complexity, i.e. properties that do not appear at lower levels, such a sex drive not found in the organs of pancreas, lungs, etc.

As the rate of change in a system's environment increases, typical of the current global economy, we observe a sequence of different system behaviors. This begins with simple adjustments to advance to new conditions, followed by others for a complete system transformation as the only means of survival (see Figure 1).

As the pressure on a system from ongoing change increases it eventually moves the system outside its "comfort zone". At this point the need to survive pushes the system to unchartered territory known as the "edge of chaos" in which there is increased creativity with an intense search for new solutions. If the search is successful the living system transforms itself with a more viable configuration, otherwise it does not survive the threats from new competitors.
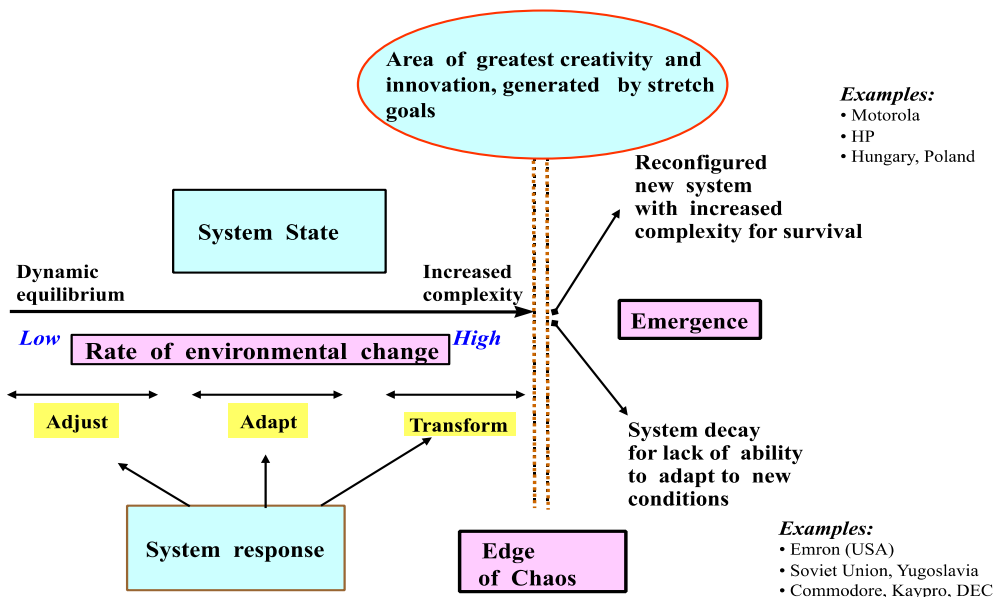

Figure 1. Degree of system complexity, the edge of chaos and emergence

A system may undergo change, yet retain its essential features and properties. Our skin is new every month, our liver is new every six weeks, our brain cells change content(in carbon, nitrogen and oxygen) every 12 months. Thus, our body is just … "a place our memory calls home, …more like a river than anything frozen in time and space" (Chopra, 1990) . *What is necessary for real change to occur is salient events.* In any process, the time interval between salient events, i.e. events that change the nature of the process, or significantly affect the

future of the process, expands or contracts along with the amount of chaos. *When there is a lot of chaos, i.e. random events in a process, it takes more time for significant events to occur. Conversely, as order increases, the time periods between salient events decrease. Chaos refers to the quantity of disordered (random) events that are relevant to the process.*

A Few Basic Premises:

1 .The rapid environmental changes in the last two decades have created impressive complexity in the business environment. These include changes in :
- Technology (computers, telecommunication, robotics, genetics, etc.)
- Economy (globalization of finance, production and e-commerce)
- Social structures and changing cultural patterns through globalization

2. To cope with increased complexity organizations either will stay the same and vanish or they must adapt in order to survive and prosper in new conditions.

3. The required changes for survival involve:
- *a change in the structure* (architecture) of the organization, i.e. flat vs. pyramid type
- *a change in the role of people* in the organization, i.e. participatory vs. command-and control

For any organization competing in the global economy, the new big challenge for leadership, as revealed in the 2010 IBM CEO survey, is to address the multiple issues generated in an environment with increasing complexity. Ashby's fundamental law in cybernetics dictates that *for an organization to survive in a changing environment with greater complexity, it must develop and maintain the same or more degrees of freedom to act, as those in the emerging environment* (Ashby, R.W., 1958). To do so, leadership must first address the need to modify the organizational architecture to handle new critical tasks, such as offshore production in a different culture, or marketing for emerging markets which calls for new business models for product design and cost, such as those in China, India, Brazil and others. Such a need is well described in an article titled "Building a second home in China" (Galvin, Jeff, et al., 2010).

Sources and types of complexity

When organizations first begin to operate in the marketplace, the degree of the complexity present in managing them is limited, because the same key actors, i.e. people are involved in setting up strategic goals and operating the day-to-day business. At this stage strategic complexity has a substantial overlap with operational complexity, because in the active internal and external networks the nodes and interactions are few and easy to understand and control. With time and growth, if the business succeeds, new kinds and layers of complexity are added in a process of *accretion*, and the relevant active networks evolve with new nodes for new functions and managers and workers inside and new customers, suppliers and oversight by government agencies (Heywood S., J. Spungin, D. Turnbull, 2007).

At the most fundamental level an organization has to manage the different kinds of complexity, best visualized as successive layers of a "complexity onion". First there is an inner layer of *inherent complexity* at the core associated with the basic characteristics required for an organization to perform needed key tasks and fulfil its mission. For example, a new small hotel must operate certain key functions, such as a reception desk to handle reservations, room cleaning, facilities maintenance, etc. The second layer refers to a *designed complexity,* which is added to provide a desired differentiation of products/services for competitive advantage. Designed complexity is associated with the desired features offered to customers, or certain process attributes, such as flexibility or reliability, needed to serve a

specific market segment. The features of DELL'S unique supply chain contribute to this component of designed complexity.

The third layer refers to *dysfunctional complexity* originating in misalignments in existing business processes from ambiguous roles and decision rules, or from disconnects in the production and distribution processes of the supply chain. Finally, the outer layer of the "complexity onion" is the *imposed complexity* from a variety of environmental conditions and constraints. These are related to government tax laws, trade laws, environmental regulations or other limitations specific to a given industry. As an organization grows and expands with more facilities, more products, more suppliers, etc. the layers of complexity increase in thickness and have further adverse impact in managing the organization both at the strategic and operational levels.

ALTERNATIVE CONDITIONS BETWEEN INTERNAL AND EXTERNAL COMPLEXITY

In order to select the appropriate leadership response, when the rate of change is significant, it is important to determine the status of organizational complexity. In studying the important relationship between internal (operational) and external (strategic) complexity, we recognize three different cases.

Case A: External Complexity Greater than Internal Complexity

The most frequent situation is one in which environmental changes have taken place at a faster pace than management has been able to adapt. This leads to an organization having to cope with greater complexity that it can deal with (see Figure 2). For example a new competitor is gaining market share thanks to a new disruptive technology, a was the case with traditional steel companies facing mini-mills or conventional bookstores having to compete with e-commerce new ones such as amazon.com.

The proper response in this situation is to try to catch-up as fast as possible to neutralize the new competitor's advantage. In the steel industry traditional companies, such as the leading US Steel and Bethlehem were slow to adapt loosing more and more market share. In the case of firms adopting the internet as a platform for e-commerce many firms adapted on time to survive, while others as in the case of large bookstore chains closed for business. The pioneer amazon.com gained such a strong advantage so as to prevail in the industry and expand broadening the product offerings to include many other products, such as music, electronics, luggage, and others.

Case B: Internal Complexity Greater than Relevant External Complexity

Quite often as a result of introducing and adding to an existing product line new products to attract customers, a firm may rapidly increase its internal complexity from unseen new requirements for planning and production these items with hidden added costs in many parts of the firm's value chain. This is a condition in which a firm has developed a richer sufficient repertoire of responses needed for its current competitive environment.

It is important to know the *tipping point* at which any added often hidden costs from new marginal value-adding new innovations outweigh any perceived benefits expected when they are introduced. An interesting example of the tipping point for a chain of 200 restaurants in California, Arizona and Nevada is the number 4. The menu offers 4 kinds of burgers, 4 different salads, 4 kinds of drinks, etc. The company found that increasing the pace of

innovation in the product line beyond a certain point, increased operating complexity leading to decreased revenues and profits. McDonald's reached the same conclusion in 2014 and began reducing the variety of items on its menu.
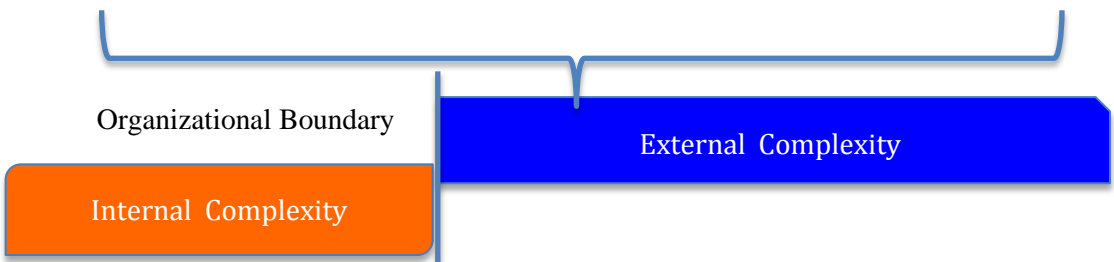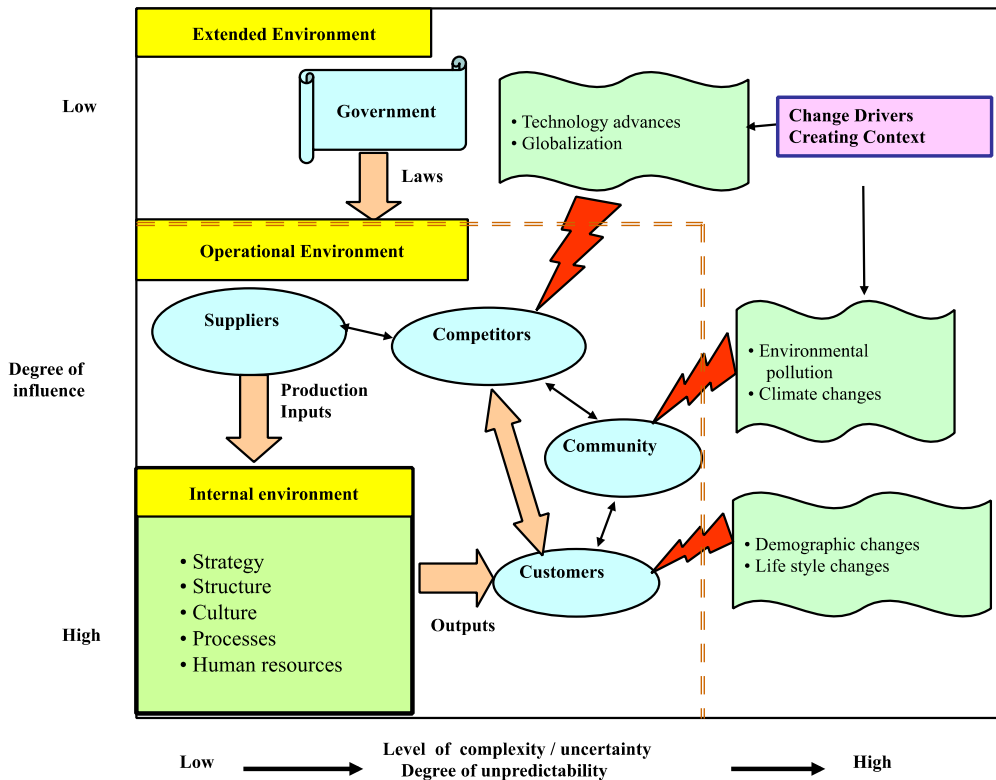

Figure 2. The key drivers of external complexity are related to changes in the firm's external environment (technology, globalization of economy, geopolitics, etc.)

In several studies, the key area for profit improvement has not been improvements in the factory, based on lean management, but improvements in the product line. So, a good approach is to begin with the *"zero-complexity baseline"* with the minimum needed features, i.e. a "Model T" level of product configuration, and then add new ones incrementally to the point this does not reduce profitability by adding hidden costs in inventories, or extra costs in manufacturing and other areas. This practice has been applied by many companies including Starbucks, Heinz, Chrysler and others) with significant increases in their profitability (Gottfredson and Aspinall, 2005).
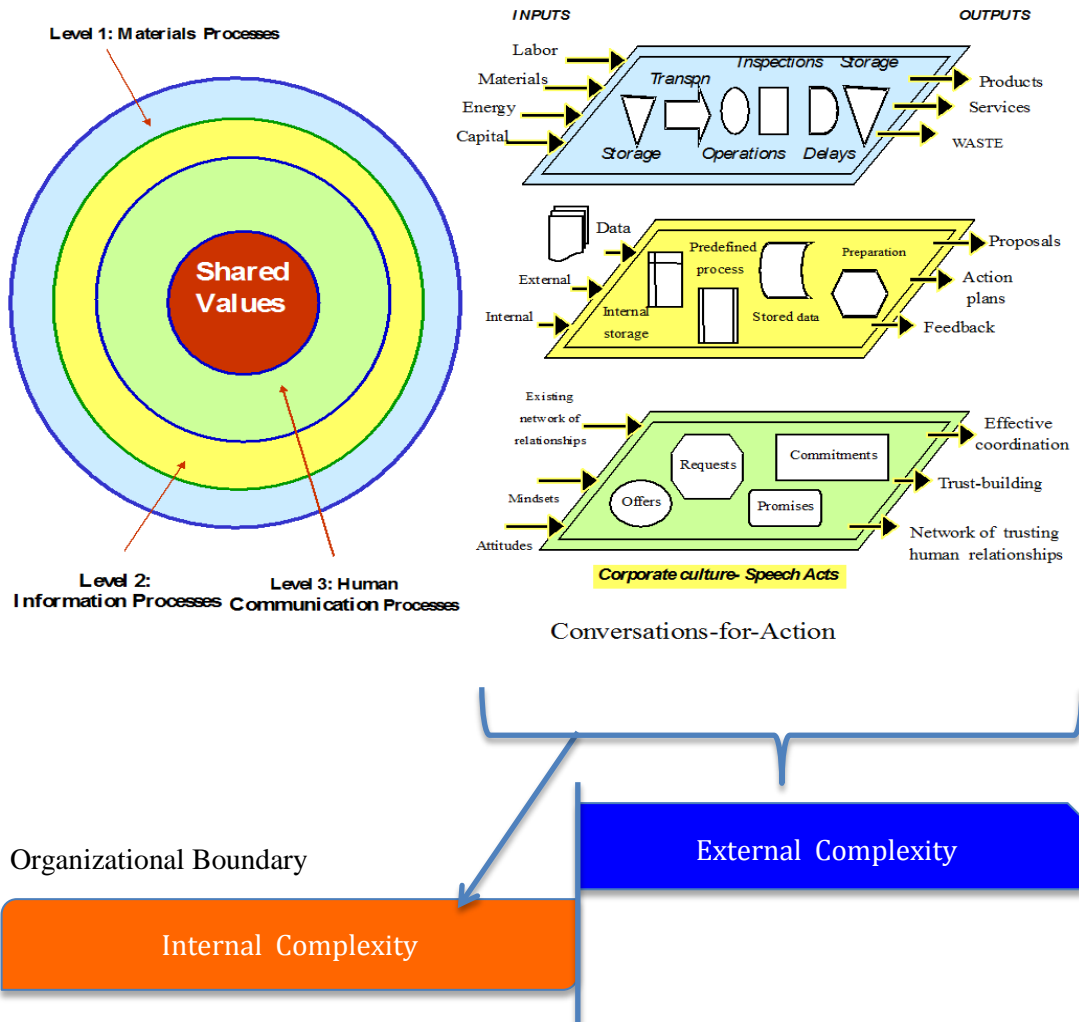
Figure 3. The three basic kinds of processes (materials, information and human communication) which determine an organization's operational complexity

In Figure 3 we see the *three basic kinds of processes* in any organization. Most visible is the "materials" processes designed to transform the production inputs of labor materials, energy and capital, in the form of machines, buildings and other assets, into products and services for which there is a demand in the marketplace.

Management is often focused on the visible *materials processes* for making tangible goods. However, for overall performance improvement there is greater leverage in the study and improvement of the less visible *information processes* which underlying all planning and control activities. Even more leverage is possible in addressing *human communication processes* conducted with conversations, especially for the purpose of negotiating desired strategic actions among key executives (Flores, 1997). The information and communication processes are the most critical for performance in the service sector, which in advanced economies (USA, Japan, Germany and others) account for 70%-80% of GDP. So, the leverage of improvements in them is much greater than similar interventions in materials processes.

As pointed out by Richard Pascale, *et al.* "… an organization's beliefs and aspirations show up in conversation…Conversation is the single most important business process when the goal is to shift what people believe and how they think…Authentic organizational

transformation always transforms conversations …the essential steps on the adaptive journey… are all reflected by shifts in conversation…All the generic techniques (for transformation of the organization) are conversation intensive…They employ public events, group discussion, and social witness in a fashion that alters what people are talking about and the way they talk to each other" (Pascale *et al.*, 2001).
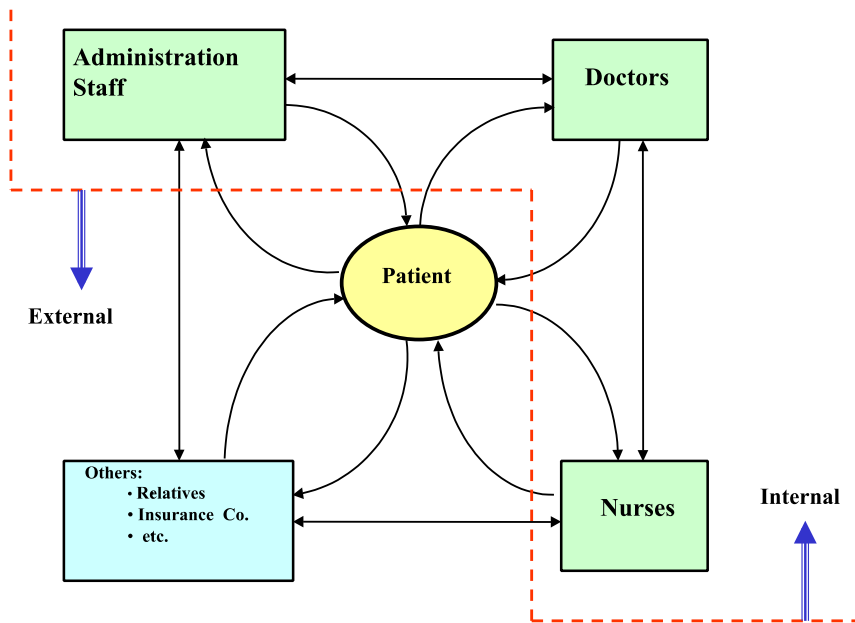

Figure 4. Conversations-for-action among participants in a hospital

Leon Tolstoy, the great 19th century Russian novelist, has described another valuable contribution of conducting conversations. He argues that it is important to develop and maintain a circle of members in our social life who represent different points of view, so that by interacting with them we can understand the different assumptions in their thinking that guide their actions. Tolstoy believed that only through such conversations with those in our circle espousing a different view one might identify the blind spots and false assumptions in our understanding which blind us to a more profound view of life and the world (Krznaric, R., 2014).

The most critical dimension of organizational activity is human coordination of action. Figure 4 illustrates the variety of conversations possible among the key actors in the treatment of a hospital patient. As a result, a central feature of organizational work is the conduct of conversations-for-action, i.e. what to do, when, how, by whom, etc., as opposed to idle conversations about the weather, sports, gossip, etc. For the example in Figure 4, doctors and nurses talk to the patient to help diagnose an illness, or to monitor the effectiveness of a selected treatment. When anyone of the basic processes is not working properly an organization experiences problems from disconnects, such a defective diagnosis, inaccurate information for planning and control of operations and bad coordination from poor communications.

The basic process elements present in all conversations-for-action include :
1. Speaking (to be listened to) to make a request or an offer for action
2. Listening (through internal conversations) to interpret what is being said
3. Emotions (the filter of human moods) that affect interpretation.

Of the above, *listening, based on one's concerns, is what matters most !*

Analyzing and interpreting conversations-for-action requires a different view of organization than the dominant industrial-era view which looked at an organization as a machine. In the new view, most appropriate for adaptive systems, we have networks of relationships represented by links connecting nodes which refer to the network elements. These might be human agents (workers, managers, etc.) that engage in conversations-for-action for the purpose of managing commitments and building trust. The *fundamental skill needed is conversational proficiency*, a relationship issue. Its importance derives from the following:

1. A leader's critical skill for problem solving depends almost completely on skill with language.
2. Nothing can be done by leaders alone. We need to create an infrastructures to mobilize teams and the organization.
3. Leaders must not be afraid to be engaged in the workings of the inner system.
4. They must focus on qualitative data rather than quantitative data to achieve a breakthrough
5. Leaders must not limit themselves to examining only the surface phenomena; rather, they must always try to capture the structure beneath the surface.

Case C: External Complexity in Balance with Internal Complexity

The desired state for an organization is one in which the internal complexity is in dynamic balance with the emerging external complexity management must cope with. As suggested by Ashby's law, there is always a strong tendency for convergence, so that a system can reach a balance between external complexity and internal complexity.

HOW COMPLEXITY AFFECTS   PERFORMANCE

An organization can attain high levels of performance when it can accomplish three distinct tasks. The *first task* is for leadership to define is strategy so as to *"do the right things"* in regard to key strategic issues of products, technologies and markets that represent the value offer to customers. The *second task* is to *"do the right things right"* which determines the efficiency of operations. This is measured by the productivity of the resources used, i.e. the productivity of labor, materials, capital invested in buildings, machines and other means of production. In addition to productivity performance the issue of productivity often includes the processing time dimension, as in the global economy many high-tech firms need to be the first in market to exploit the advantages offered by new innovations. The *third task* is to *enable the optimum utilization of the system available capacity*. This involves using fully and productively the total system capacity.

All of the above tasks are affected by how leadership can address the present level of complexity. The measure of success in addressing them is one of total organizational performance, specified as follows:

"Total organizational performance"	**=**	**performance achieved by organizational "hard" processes**	**X**	**performance achieved by organizational "soft" processes**

The above factors may be measured on unit-free scales (0-1.0), with values obtained from benchmarking studies conducted for members of the same industry, as for example power utilities in the US.

Success in exploring and confronting external and internal complexity depends on the quality of the conversations-for action leaders and managers conduct within an organization. This quality depends on the quality of:

a. Conversation for effectiveness, i.e. for doing the right things.
These are determined by conversations for relationships and by conversations for opportunities. Which market segment(s) need a new market offering, in terms of generating a stream of growing value in revenue and profits ?

b. Conversation for efficiency, i.e. for doing the right things right.
These are determined by conversations for actions and by conversations for process breakdowns in the flow of materials, information and communications.

c. Conversations to achieve a desired level of trust affecting coordination for optimum capacity utilization.

All of the above are determined by the fitness of matching job roles to personal motives and by matching job roles to personal values.

The key dimensions of valuable trust in a relationship involve:
1. *Sincerity*: the degree to which people mean what they say and whether their promises are shallow or deep.
2. *Competence*: whether a person has the capability to fulfill a promise made sincerely. Managers are always making such assessments, for example in considering if a person can keep up with the speed at which the organization has to move.
3. *Involvement or care*: how well a person can appreciate and care about someone else's concerns and, in particular, one's own concerns.

Someone may be sincere and may even have the competence to do something for me, but may not have taken the time to truly understand what I consider important and how one's business situation is changing.

DEVELOPING BALANCE BETWEEN INTERNAL AND EXTERNAL COMPLEXITY

Recognition that an organization is a complex living entity in which human resources are becoming the dominant influence for its viability and success suggests that sustainable performance improvement requires the participation of all employees (Pfeiffer,1998). Ackoff, Senge, De Geus and others have expressed the view that human intelligence and ability to learn represent in our times an organization's most important sustainable competitive advantage (Senge,1990; De Geus,1997).

The outcome of all organizational activities always depends on how people at work relate to one another. In an era of interdependence, performance can be greatly improved by building up an organization's social capital, as a *prerequisite* of implementing a good strategy. This is accomplished by:
1. Encouraging and facilitating the operation of informal networks
2. Creating conditions that strengthen human trust
3. Providing needed space and time for informal human interaction
4. Encouraging social talk and story telling
5. Maintaining a healthy balance between face-to-face and virtual
     means of communication (e-mail, teleconferencing, etc.)

In attempting to develop more effective ways to confront organizational complexity, it is essential to understand how leaders and managers spend their time at work .
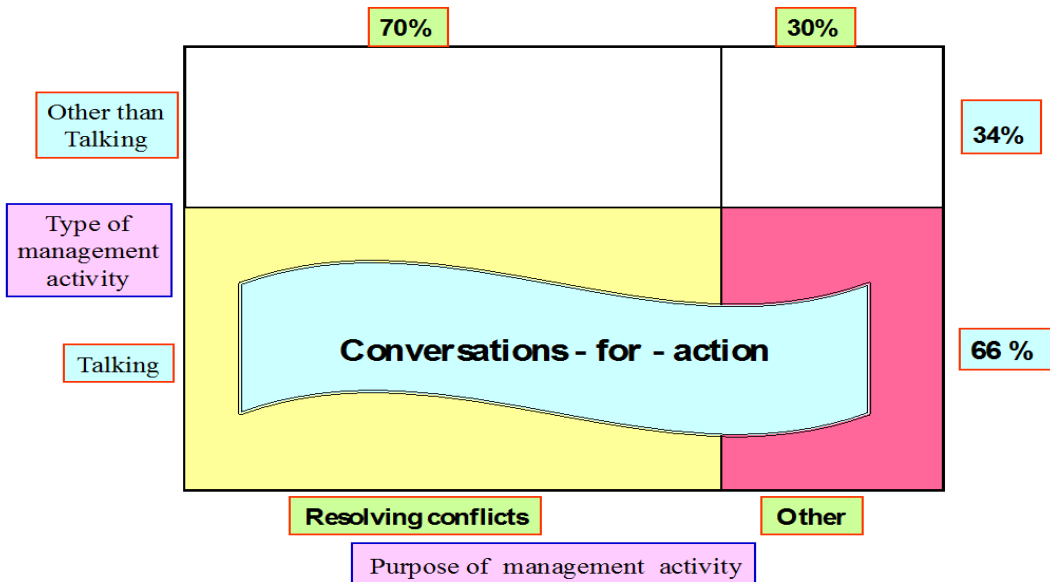
Figure 5. How leaders and managers spend their time

In Figure 5 we note that of all the time spent at the workplace managers spent 66% of the time talking, i.e. in conversations-for-action, and 34% engaged in other non-talking activities. The first kind includes those conversations that matter, i.e. (1) For searching, coordination, decisions and action, (2) For building personal relationships. Of the total time managers are engaged in conversations-for action, 70% is about resolving conflicts.

Donella Meadows suggests how one might intervene to improve a system and identifies the following nine leverage points, listed in order of importance and increasing resistance to change, as seen in Figure 6 (Meadows, 1997):

Level 9. Numbers (about product or process specifications, standards, etc., i.e. system
     parameters).

Level 8. Material stocks and flows (inventories and production rates, i.e. system
     variables).

Level 7. Regulating negative feedback loops (which slow down a process).

Level 6. Driving positive feedback loops (which speed up a process).

Level 5. Information flows (say enriching communication with real-time data).

Level 4. The rules of the system (incentives, punishment, constraints).

Level 3. The power of self-organization (through making employees as the "nodes"
     stronger and the communication "links" richer).

Level 2. The goals of the system.

Level 1. The mental model /mindset out of which the goals, rules, and feedback
     structure arise.

The sequence of interventions over time provides management a road map to performance excellence. As leadership attempts to bring about change using higher level intervention points, there is increasing resistance to change from workers and lower levels of management already accustomed to operate with another mindset.
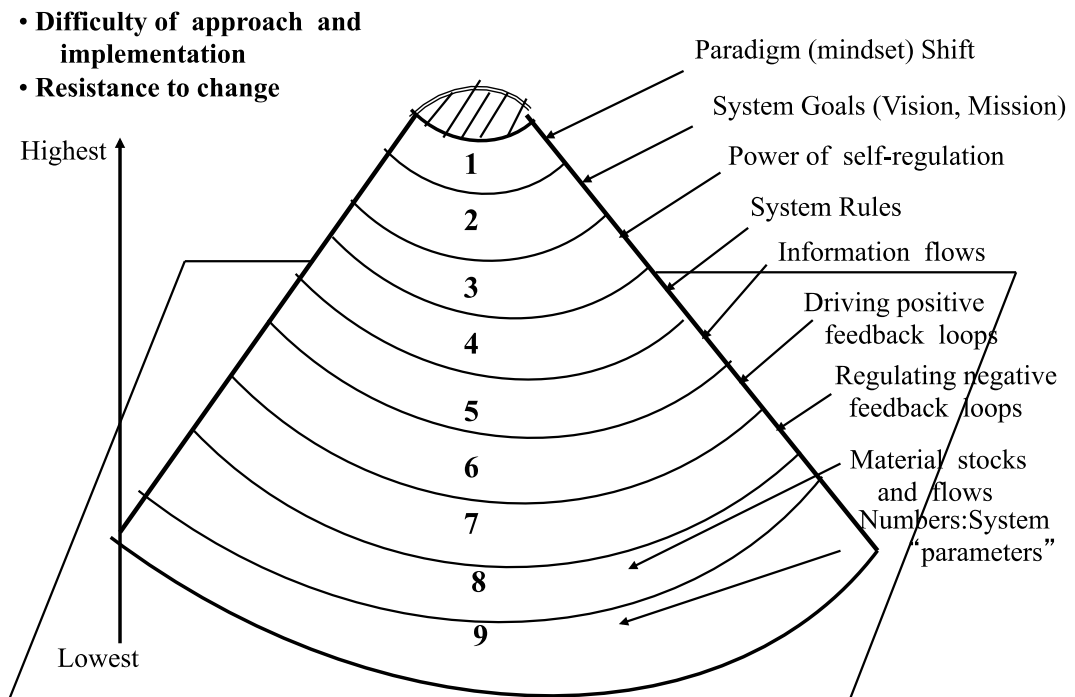
- **Difficulty of approach and implementation**
- **Resistance to change**

Highest

Paradigm (mindset) Shift

System Goals (Vision, Mission)

Power of self-regulation

System Rules

Information flows

Driving positive feedback loops

Regulating negative feedback loops

Material stocks and flows

Numbers:System "parameters"

1
2
3
4
5
6
7
8
9

Lowest

Figure 6 . The Meadows hierarchy of leverage points for increasing effectiveness and efficiency in system performance (Daniella Meadows, Places to Intervene in a System, *Whole Earth*, 1977)

The proposed intervention points might be grouped in three categories which roughly correspond to the fundamental types of organizational processes we discussed previously. Points 9 and 8 refer to the system's "plumbing structure ", i.e. those processes in which we have material flows. Points 7 through 4 address issues more closely related to the processes affected by information flows. These generally allow greater leverage for improvements. Finally, leverage Points 3, 2 and 1 seem most relevant to the human communication processes that require conversations-for-action. Having the greatest leverage, these often invisible points of intervention offer the greatest promise for big and sustainable system improvements.

In Figure 7 we see how *operational complexity is related to the different levels of strategy execution, i.e. the organizational, the process and the worker levels of a firm* (Rummler and Brance,1995). Dealing with the "soft" stuff, i.e. human feelings and attitudes in the *affective domain* is much more difficult than working with the "hard" stuff , i.e. rational thinking and decisions *in the cognition domain. Effectiveness depends largely on skills with language data, especially critical for leadership and teamwork.*
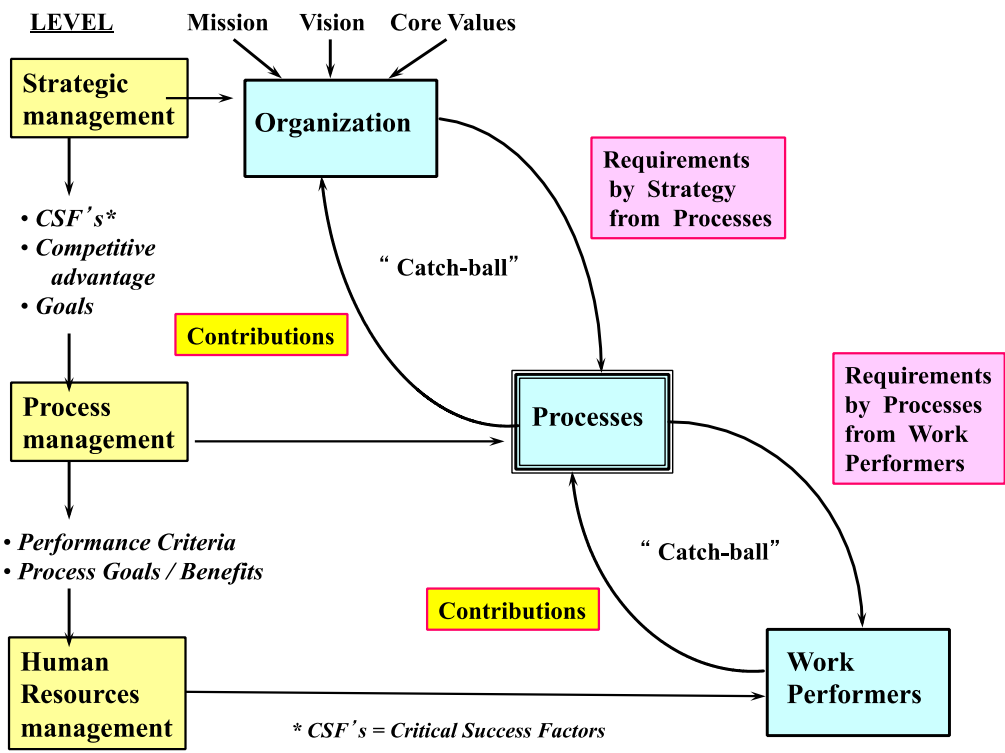
Figure 7. Operational complexity derives at different levels of strategy execution

However, as shown in Figure 8, it is the quality of the leadership "conversations for doing the right things" that will ultimately determine how successful an organization will be in addressing the increasing strategic complexity caused by the uncertainty and volatility of today's environment.
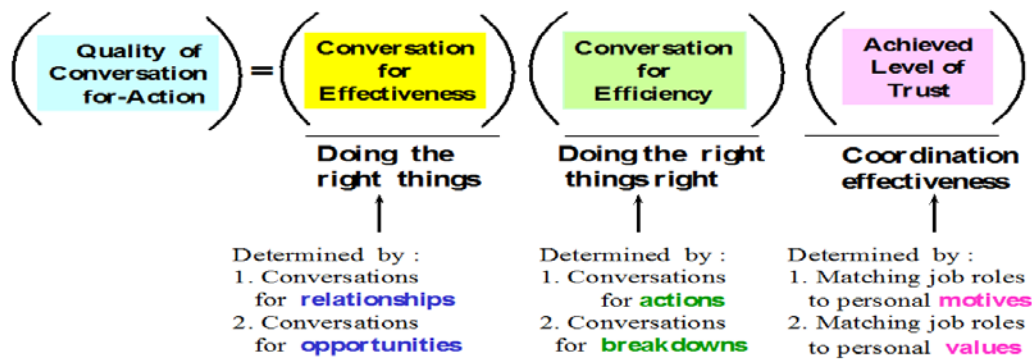

Figure 8. Factors which define the quality of a "conversation-for-action" in management

This depends on the conversations related to a firm's effectiveness, i.e. doing the right things, in terms of strategic goals, conversations for efficiency in terms of best use of available

resources and conversations for building and maintaining the trust needed for optimum coordination.

Approaches for Facilitating More Effective Conversations

Two methods developed to overcome the problem of conveying and interpreting more effectively the meaning in a message are in the theories of Chris Argyris and David Bohm. Argyris has developed and used effectively the concept of a mental model as the basic filter by which each person interprets and responds to changes in one's environment. Briefly, a mental model is the sum total of our assumptions about our reality and how these affect the way we interpret what is said and happening around us. Most of these assumptions are often operating at the unconscious level, which means we are not aware of their influence (Argyris, 1997).

By using the techniques of the "ladder of abstraction" and the "left-hand and right-hand-column" Argyris aims to assist in surfacing all the crucial assumptions and test their validity in the context of the conditions that exist when a conversation takes place. For example, while many executives appear to accept the premises of McGregor's humanitarian Theory Y about the nature and motivation of their employees (as their "espoused theory"), they run their organizations based on assumptions that are part of the authoritarian and autocratic Theory X (this being their "theory in use"). Mass layoffs in several industries to reduce costs in the last months of 2001, following the economic slowdown due to the recession and the terrorist attacks of September 11, suggest that human resources in the era of globalization as we know it do not count as much as we hear. Bohm's approach rests on the practice of developing a genuine dialogue, as a free flow of ideas that people exchange in searching for the validity of their interpretation of what is said in conversation (Bohm, 1997: Senge,1990).

Well-Established Approaches Which Cannot Help In A Complex Situation

For several decades after World War II managers were trained in business schools to employ a variety of techniques from statistics, operations research and more recently from TQM (Dahlgaard Su Mi, 2011) and Six Sigma. Under conditions of relative stability and limited complexity these techniques proved effective in improving performance, mainly when efficiency and quality issues where most important. However, in today's volatile and uncertain environment the above techniques are of limited or no use.

1. Optimization techniques, such as linear programming, assume that system parameters, such as energy or materials inputs, remain stable over time. When the price of oil drops nearly 50% in a just a few months as it did in 2014, such an assumption is not valid.
2. Much of the success of the popular Six Sigma approach for reducing variation to develop lean systems is also limited when there is a need to enhance variation, so as to explore a variety of meanings in conversations which determine impacts of actions on effectiveness, i.e. on strategic issues.
3. The elimination of redundancy of system components to reduce operating costs proves dangerous in conditions where we want systems to be flexible and adaptive in a rapidly changing environment.
4. The use of conventional forecasting techniques to anticipate future levels of demand prove misleading when the underlying factors that affect demand change dramatically and there is a need for greater value for flexibility and system robustness to survive and adapt, compared to aiming for increased accuracy

In coping with an ever growing environmental uncertainty and volatility there is a need for maintaining buffers in time and space together with reducing the degree of interdependence among critical system components. These become issues that assume increasing importance

and create an urgency for leadership to "jump the curve" to a new mindset or paradigm, as a necessary condition for survival and success in the 21st century (see Figure 9).

CONCLUSIONS

With complexity presently ranking as the greatest challenge for leadership, following many years of concern with change (IBM 2010 survey), it is crucial to develop a better understanding of complexity as the key factor affecting performance and competitiveness. Only in this way will it be possible to bridge the *complexity gap* which refers to the difference between expected complexity and the extent to which CEO's believed they are prepared to manage it. In this paper we describe the distinct forms of strategic complexity generated in the environment and operational complexity generated internally by the design and operation of the basic organizational processes for materials, information and communication.

The challenge for leadership is to improve the performance of these three processes, especially the information and communication processes which have the greatest leverage on performance. Again we return to the paramount importance of the 'soft' human-related processes which depend on language-based skills, rather than on hardware and algorithms for improvement. To achieve superior sustainable performance, leadership must "jump the curve" to a new mindset and develop language skills that impact both the "do the right things" and " do the right things right" aspects for excellence in quality and innovation.

REFERENCES

Argyris C. and D.A.Schon (1985), *Organizational Learning II: Theory, Method And Practice*, Addison-Wesley, New York

Ashby, R.W. (1958), "Requisite variety and its implications for the control of complex systems", *Cybernetica*, 1,(2), 83-89

Barabasi, Albert-Lazlo, *Linked*, Plume Books- Penguin, New York, 2002

Birkinshaw Julian and Suzanne Heywood, Putting organizational complexity in its place, *McKinsey Quarterly* (mckinseyquarterly.com), May 2010.

Bohm D. (1983), *Wholeness And The Implicate Order*, Ark Paperbacks, New York

Buchanan , Mark, *Nexus*, *Small Worlds and the Groundbreaking Science of Networks,* W. W. Norton, New York , 2002

Chopra, Deepak, *The New Physics Of Healing*, 1990

Conti, Tito (2009), Systems thinking: the new frontier in quality management, *Proceedings 53rd EOQ Conference*, Dubrovnic, Croatia, May 2009

Dahlgaard Su Mi (2011), The quality movement: Where are you going? , *Total Quality Management & Business Excellence*, Vol. 22, No. 5-6

DeGeus A.(1997),*The Living Company*, Harvard Business School Press, Boston,Mass.

Dervitsiotis, K. (2013), An Innovation-based approach for coping with increasing complexity in the global economy, *Total Quality Management & Business Excellence*, Vol. 24, No. 6

Dervitsiotis, K. (2011a), The challenge of adaptation through innovation based on the quality of the innovation process, *Total Quality Management & Business Excellence*,Vol. 22, No. 5-6

Dervitsiotis, K. (2010), Developing Full-Spectrum Innovation Capability for Survival and Success in the Global Economy, *Total Quality Management & Business Excellence*, Vol. 21, No. 2, February 2010, 157-168

Dervitsiotis, K. (2007), On Becoming Adaptive: The New Imperative for Survival and Success in the 21st Century, *Total Quality Management & Business Excellence*, Vol.18, No.1- 2

Flores, Fernando (1997), *Future Leaders*, in Denning P.J. and R.M. Metcalfe (eds), *Beyond Calculation* , Copernicus Press, New York

Galvin, Jeff, Jimmy Hexter and Martin Hirt, Building a second home in China, *McKinsey Quarterly*, (mckinseyquarterly.com2010), McKinsey & Company, pp. 1-19

Gottfredson Mark and Keith Aspinall (2005), Innovation Versus Complexity: What is Too Much of a Good Thing , *Harvard Business Review*, November 2005

Heywood Susanne., Jessica Spungin, David Turnbull, *Cracking the complexity code*, McKinsey Quarterly (mckinseyquarterly.com) , May 2007 .

IBM Executive Survey (2010), Capitalizing on Complexity: Insights from the Global Chief Executive Officer Study

Krznaric, Roman (2014), *The Wonderbox: Curious Histories of How to Live,* Digital Empathy Library

Meadows Daniella (1997), Places To Intervene In A System, *Whole Earth*,Winter 1997

Pascale R. et al. (2001), *Surfing the edge of chaos*, Crown Business, New York

Pfeiffer J. (1998) ,*The Human Factor*, Harvard University Press, Boston

Rummler G. A. and A. P. Brache, *Improving Performance*, 2nd ed. Jossey-Bass, San Francisco, 1995

Senge, P. (1990), *The Fifth Discipline: The Art And Practice Of The Learning Organization*, Doubleday, New York