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Article

Technological, managerial and organizational capabilities of customer-centric organizations

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Technological, managerial and organizational capabilities of customer-centric organizations

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Abstract

This paper examines characteristics and limitations of past and current manufacturing organizations, and it extends their frontiers by proposing technological, managerial and organizational capabilities which configure the new face of the industrial organization in the 21st century. From such an analysis, it introduces the concept of customer-centric systems which represent new organizational production models that pursue high degrees of organizational cognition, intelligence and autonomy, and consequently, high degrees of agility and flexibility, in order to manage high levels of environmental complexity, to operate through intensive mass customization, and to provide customers with immersiveness. From all these backgrounds, this research contributes by proposing the concept of new organizations with structure and processes of computational organization management networks. In such a new organization type, cognitive machines and cognitive information systems are prominent actors of governance, automation and control of the whole enterprise.

Keywords: Organization Design, Cognitive Machines, Immersiveness, Computational Organizational Management Networks.

1. Introduction

This paper mainly relies on principles of incompatibility, or non-equilibrium, existing between the continuous growth in the level of environmental complexity and the insufficient cognitive capacity of the organization to deal with higher levels of uncertainty, to operate in complex task environments, to attend new market demands, to manage new approaches to customers' satisfaction and relationship, and to capture effectively information resources from the environment. Such a premise has motivated organizations to pursue higher degrees of cognition, intelligence and autonomy through principles of organization design (Nobre, Tobias & Walker, 2008, 2009a, 2009b, 2010a).

Therefore, this paper focuses on the general picture of organizations pursuing high degrees of cognition in order to improve their capabilities of information processing, knowledge and uncertainty management. It assumes that improvements in the degree of organizational cognition can lead the

organization to achieve higher degrees of flexibility and agility, to operate through higher levels of mass customization (Pine, 1999), and to provide customers with immersiveness. In a broader sense, such improvements extend the capability of the organization to manage higher levels of environmental complexity. In such a context, flexibility means capability to reconfigure and to adapt to new operational and management conditions (Toni & Tonchia, 1998); and agility means the ability to manufacture a variety of products at low cost and in a short period of time (Lee, 1998). This paper supports existing works on manufacturing systems (Kusiak, 2000; Monfared & Steiner, 1997) and industrial organizations (Nobreet *al.*, 2008), and additionally, it extends past and present concepts by proposing new technological, managerial and organizational capabilities which have to be developed in order to satisfy the requirements and to configure the new face of the industrial organization in the 21st century. First and foremost, this work aims to give insights and answers to the questions in the following whose responses are blended over this full paper:

- a. What is the nature of this new industrial organization face?
- b. Why is this face important in the 21st century?
- c. What are the critical success factors of this face?
- d. What steps are required to create this face?
- e. What would be the future of this face?

Chronologically, this work first introduces concepts of organizations and machines which are fundamental for the understating of this research. Such concepts comprise organizational cognition, uncertainty and environmental complexity, along with cognitive machines. Second, it proposes the concept and the features of Customer-Centric Systems (CCS). CCS represent new organizing models of production that pursue high degrees of organizational cognition in order to manage high levels of environmental complexity, to operate through intensive mass customization processes, and to provide customers with immersiveness. Third, this research outlines the development of manufacturing systems and organizations through complementary perspectives of technology, management and organizational systems theory, respectively. As a result of the analyses, it indicates limitations of past and current manufacturing organizations which motivate the proposal of the new frontiers, concept, and features of Customer-Centric Systems (CCS). Forth, from all these interdisciplinary backgrounds, this research also contributes by proposing the concept, structure and processes of Computational Organization Management Networks (COMN), which are new organizations with the capability to implement the features of Customer-Centric Systems (CCS). In COMN, cognitive machines and Cognitive Information Systems (CIS) are prominent actors of governance, automation and control of the whole enterprise (Nobreet *al.*, 2008, 2009a, 2010a).

2. Key concepts of the organization

2.1. Customer-Centric Systems: Main Features, Benefits and Importance

This subsection introduces the characteristics of Customer-Centric Systems (CCS) which are further developed throughout this paper. The concept of CCS was firstly touched in (Nobre& Steiner, 2002), and latterly it was further developed in (Nobreet *al.*, 2008, 2009a, 2010a). Briefly, CCS represents organizational models with capabilities to:

- (i) Manage high levels of environmental complexity.
- (ii) Operate through high levels of mass customization.
- (iii) Pursue high degrees of organizational cognition, intelligence and autonomy, and consequently, high degrees of flexibility and agility.
- (iv) And provide customers with immersiveness.

This paper proposes that Customer-Centric Systems (CCS) are firm types which strategically organize their resources and competencies around customers' values and needs, in order to involve customers into their business. By involving customers into their task environments and business, CCS-based organizations have the chance to understand and to produce the real needs, goods and services, to their clients.

2.2. Organizations

Organizations involve participants, technology, goals and coordinative social structures in order to manage their resources and competences, and to cope with the environment. Participants are the agents which act in the name of the organization. Technology expands what organizations can do and it supports the connection of the organization to the environment. Goals and sub-goals are what organizations aim to achieve in order to satisfy their desires. Social structure refers to the standards and regularized aspects of the relationships existing among the participants in the organization; it comprises normative and behavioral structures (Scott, 1998). The environment includes information, consumers and stakeholders, other organizations like buyers and suppliers, networks of organizations, institutions, market regulators, the whole economy, cultural values and natural resources (Milgrom& Roberts, 1992).

2.3. Limitations of Organizations

Contingency theory (Galbraith, 1973, 1977) has defined uncertainty as the variable which makes the organization contingent upon the environment. Hence, organization design, and thus organizational

choice, depends on the concept of uncertainty. Briefly, uncertainty can be associated with propositions of bounded rationality theory by carrying the meaning of (Nobreet *al.*, 2009a):

- a) Lack of information, which leads the organization to unpredictability of outcomes.
- b) And, insufficiency of cognitive capacity for general information-processing.

The former, lack of information, means that uncertainty is the difference between the total amount of information that the organization needs to have in order to complete a task, and the amount of information in possession of the organization. The latter, insufficiency of cognition, means that uncertainty is the difference between the degree of cognition that the organization needs to have in order to complete a task, and the degree of cognition in possession of the organization.

These two approaches to uncertainty are complementary to each other since the greater the amount of information that the organization needs to have in order to perform and to complete a task, the greater is the degree of cognition that the organization needs to have in order to process and to manage this information for task execution and completion. Figures 1 and 2 illustrate such concepts of uncertainty using symbolic scales of measurement.

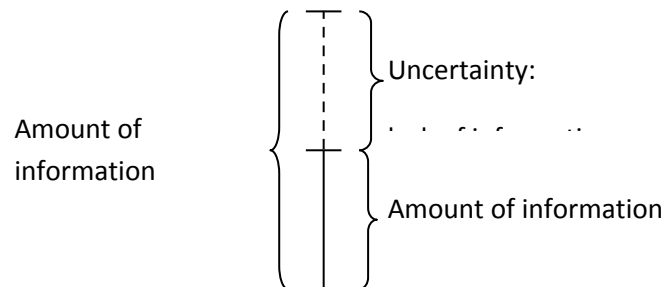


Figure 1. Uncertainty as Lack of Information

(source: author)

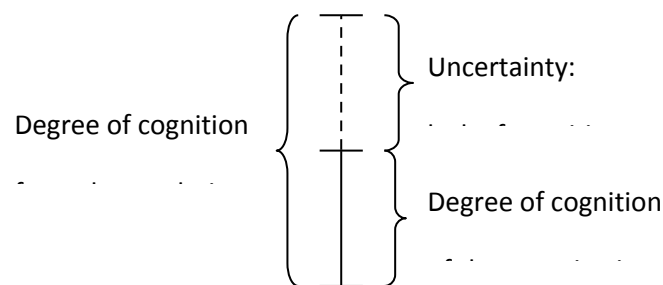


Figure 2. Uncertainty as Lack of Cognition

(source: author)

Therefore, the question which rises in our quest is: - what to do in order to reduce the level of uncertainty that the organization confronts and needs to manage? Organizational cognition has an important part into such a perspective and therefore it is introduced in the next subsection.

2.4. Organizational Cognition

Research on cognition in organizations has its roots in the publications of Simon (1947) on *Administrative Behavior*, and March and Simon (1958) on *Organizations*. In these publications, the organization was associated with information processing systems whose picture resembles a nexus of cognitive agents and processes organized through lateral and vertical relations. In this perspective, the organization benefits individuals and groups by extending their cognitive limitations to more advanced models of rationality (Simon, 1997a, 1997b). However, the meaning of this perspective has been separated by some researchers in two main streams: the computational and the interpretive approaches (Lant&Shapira, 2001). The computational approach investigates the processes by which the organization manipulates information, and it associates the organization with information processing machines. In such a stream, the emphasis is on information and efficiency. This approach is grounded in cognitive psychology, cognitive science and artificial intelligence. The interpretive approach examines how meaning is created around information in a social context, and it is related to social collectives and knowledge systems. In such a stream, the focus is on knowledge and collectivities. This approach has been grounded in the sociology of knowledge, social psychology of organizations, social cognition, and, most recently, in knowledge management and organizational learning, whereas this latter subject has also been associated with processes for creating, retaining and transferring knowledge in organizations (Argote, 2007).

Most of the perspectives on organizational cognition are placed somewhere in the continuous between such computational and interpretive approaches. In this paper, the authors give special attention to the computational perspective and they use the metaphor of the organization as information processing systems. In such a perspective, organizational cognition is concerned with the processes which provide agents and organizations with the ability to learn, to make decisions and to solve problems. The main agents of organizational cognition are the participants within the organization and the social networks which they form. In organizations, cognitive processes are supported by their goals, technology and social structure. Moreover, organizational cognition is also influenced by inter-organizational processes and thus by the environment. Therefore, the choice of the organization elements (participants, technology, goals, and social structure), and thus organizational design (Galbraith, 2002), plays a fundamental task in organizational cognition. The cognition of the organization can be represented as a matter of degree whose level depends on the choice of the organization elements.

From such a context, this paper proposes new principles, concepts and features of Customer-Centric Systems (CCS) which configure the new face of the industrial organization in the 21st century. These organizations are emerging in order to pursue higher degrees of cognition and greater capabilities of general information processing and uncertainty management.

2.5. Organizational Intelligence, Autonomy and Complexity

Like organizational cognition, definitions of organizational intelligence, autonomy and complexity are proposed in (Nobreet *al.*, 2009a, 2010b). Nevertheless, they are briefly defined in this section.

Organizational Intelligence: Intelligence is a general mental ability (Schmidt & Hunter, 2000), which depends on rational and emotional processes. Organizations pursue intelligence through the support of their elements (participants, social structure, technology and goals). Similarly to cognition, intelligence is a matter of degree. Moreover, the greater the degree of cognition of the organization, the greater is its chance to exhibit intelligent behavior.

Organizational Autonomy: This paper regards autonomy as the ability of an organism to act through the use of cognition. Similarly to cognition and intelligence, autonomy is a matter of degree. Additionally, the greater the degree of cognition of the organization, the greater is its autonomy.

Organizational Complexity: This paper defines the level of complexity of the organization as contingent upon its degree of cognition. Therefore, the complexity of organizations are synonymous with their cognitions which are processes used to solve complex tasks. Hence, the greater the degree of cognition of the organization, the greater is its ability to solve complex tasks.

2.6. Environmental Complexity

The complexity of the environment is contingent upon the level of uncertainty that it represents to the organization. Similarly, the complexity of a task environment is contingent upon the level of uncertainty that it represents to the organization during task execution and completion. Therefore, it can be asserted that the greater the level of environmental complexity, the greater is the level of environmental uncertainty that the organization confronts and needs to manage.

2.7. Cognitive Machines

Initial lines of contribution on the perspectives of cognitive machines in organizations were first touched in (Nobre, 2008; Nobreet *al.*, 2009a, 2009b).

Cognitive machines are information processing and knowledge management systems which unify computational and cognitive strengths of humans and computers. They are necessary when we need to extend the reasoning or mental capacity of humans, groups and organizations to more advanced models of cognition. Cognitive machines are agents whose processes of functioning are mainly inspired by human cognition. Therefore, they have great possibilities to present intelligent behavior. When participating in organizations, cognitive machines are agents of organizational cognition and they

contribute to improve the degree of cognition, intelligence and autonomy of the organization. Intensive and extensive research on the design and analysis of cognitive machines in organizations is proposed in (Nobreet *al.*, 2009a, 2009b). The design of cognitive machines comprises theories of cognition and information-processing systems, and also the mathematical and theoretical background of Fuzzy Systems (FS), Computing with Words (CW) and Computation Theory of Perceptions (CTP) (Nobreet *al.*, 2009a, 2009b). This class of machines has the capabilities to carry out complex cognitive tasks in organizations, and in particular the tasks which involve representation and organization of knowledge via concept identification and categorization along with the manipulation of perceptions (percept), concepts and mental models. The ability of these machines to manipulate complex symbols described in the form of words and sentences of natural language provides them with higher levels of information-processing than other symbolic-processing machines; and according to the theory of levels of processing in cognition (Reed, 1988) these machines can mimic, even through simple models, cognitive processes of humans.

Similarly to the definitions of organization intelligence, autonomy and complexity, it can be stated that the greater the degree of cognition of the machine, the greater is its chance to present intelligent behavior; the greater is its autonomy; and the greater is its ability to solve complex tasks. The concept of cognitive machines plays an important role in the new face of the organizations proposed in this research. These machines participate in the organization and they provide the organization with higher degrees of cognition, intelligence and autonomy as investigated in (Nobreet *al.*, 2009a, 2009b).

3. Analyses of critical success factors of Past and Future Organizations

This section analyses past and current manufacturing organizations through three complementary perspectives of technology, management and organizational systems theory. It asserts that the convergence of manufacturing organizations to the new features of Customer-Centric Systems (CCS) is contingent upon the continuous growth in the level of environmental complexity. It emphasizes that CCS configures the technological, managerial and organizational capabilities which industrial organizations need to have if they want to manage higher levels of environmental complexity in the 21st century.

3.1. Technological Perspective

From Past to Present: The Industrial Revolution, covering periods in the 18th, 19th, and 20th centuries, introduced new elements to modern organizations, in the form of powerful machines. Such machines challenged humans by replacing their muscular activities and handicrafts with the work of hydraulic, mechanical, and electrical mechanisms. The transition from post-industrial factories to the organizations of today has been marked by the shift of attention from energy to information. Such an innovation was possible because of the advancements in information technology systems which developed mainly from the second half of 20th century. Since then, the world has been moving towards new directions to

rationalize energy and to empower information-demanding machines. The new information-processing machines benefit people by supporting and executing more complex cognitive tasks in organizations than machines of any previous period. They give people additional resources to automate tasks at higher layers in the organization and to extend the frontiers of the organization to the global market. Moreover, with the advent and popularization of digital computers, software programs and communications networks, new tools emerged in order to support the analysis and design of processes and systems of higher order of complexity in organizations. It is into such a perspective of transition that manufacturing systems evolved towards higher levels of complexity.

The emergence of mass production systems in the beginning of the 20th century was encompassed by the consolidation of more structured manufacturing organizations, and therefore, new machinery and management technologies were developed for the analysis and design of such new enterprises. Pneumatic tools and analogue machinery systems were used to support shop floor operations and processes. The interdependence between the manufacturing organization and the environment was neither treated with the necessary relevance nor too much considered by the organizations at that time. Static and linear modeling was the main mathematical tool used for the analysis of such systems. Human presence was mainly on the shop floor level and new management processes and roles started to be structured in the organizations. Therefore, humans with years of experience in shop floor activities used to play an important part in that period, where they could use their skills to execute tasks such as adjusting appropriately to differences in the size, shape and orientation of production systems' parts (Kusiak, 2000).

The transition from mass to batch production systems was empowered by the emergence and application of digital computers. Such technology provided a shift from single-purpose machines to multi-purpose and more flexible machinery systems. Programmable systems arose and evolved in such a way that many functions and tasks could be performed on a single hardware platform. More variables, more complex dynamics and behavior were incorporated into the manufacturing systems of batch production. The interdependence of the organization with the environment grew in relevance and complexity. Cybernetics models have been used for the analysis of such systems, and in particular, concepts of information and feedback control with self-regulation have been adopted for this purpose. Stochastic and non-linear systems accompanied by operational research and artificial intelligence techniques have been the mathematical and logical tools used for the analysis of such new organizational systems of batch production. Human presence has grown in the higher layers of the organization in order to occupy new management and strategic roles, and to execute managerial tasks at the shop floor. Therefore, humans with experience in the management of shop floor activities have played an important role for the transition from mass to batch production models (Wu, 1994). These activities include process planning, equipment selection, cellular configuration, facility layout, along with suppliers' coordination and workers' supervision, material resources planning, as well as the operation of Computer Integrated Manufacturing (CIM) systems.

Technological Limitations: The continuous growth in the market dynamics, accompanied by the general growth in the level of environmental complexity, has challenged organizations and demanded them the

search for new solutions of technological basis. In order to realize such innovations, organizations have pursued the design of flexible manufacturing and agile machinery systems (Lee, 1998; Nobre& Steiner, 2002; Steiner, de Vicq, &Medland, 2001; Toni &Tonchia, 1998). However, the need for higher degrees of flexibility and agility, in order to cope with higher levels of environmental complexity, has grown in such a way that the capability of current manufacturing organizations to deal with higher levels of uncertainty has reached a threshold since the current and dominant technological state of the art has found its limits of contribution. For this reason, new technologies have been emerging to complement the past and current ones, and also to extend the capabilities of the organization when operating in environments of higher levels of complexity. The incompatibility, and the non-equilibrium, between market demands, characterized by accentuated growths in the level of environmental complexity, and the insufficient capabilities of current technologies has been motivating the gradual transition from production models of manufacturing organizations of today to the new organization of Customer-Centric Systems (CCS).

The gradual migration from mass and batch production models to the proposed Customer-Centric Systems (CCS) has some technological implications to the new manufacturing organizations. The model of CCS provides the organization with higher degrees of cognition in order to deal with higher levels of environmental complexity. However, the convergence to this new organizing model generates a continuous growth in the level of complexity of the organization's task environment. Consequently, a growth in the level of task complexity demands from the organization the search for alternative solutions which include the design of new elements that comprise technology of machines along with manufacturing and operations management processes. These new elements are supposed to provide the organization with higher degrees of cognition along with flexibility and agility in order to produce and to satisfy customers' exact needs and also to attend a new market that demands new services and goods. These implications can be summarized by (Nobreet *al.*, 2009a):

The Technological Threshold Principle: The continuous growth in the level of environmental complexity demands from the organization the pursuit of continuous growth in the degree of flexibility and agility. This dependence will reach a threshold where the dominant technological state of the art will found its limits of contribution.

Into such a technological context, cognitive machines play an important task by participating in the new organization and by improving its cognitive capacity.

From Present to Future - New Technological Core Competencies of CCS: The model of Customer-Centric Systems (CCS) is characterized by high degrees of flexibility and agility, and in such a view, the technology of cognitive machines will play an important role in organizations of this type. In the perspective of CCS, humans are less present in shop floor as well as in management activities since cognitive machines will tend to occupy technical and managerial positions in the organization. What is less obvious is that the organizations that will operate according to the CCS properties will need more efficient and effective ways to capture resources from the environment than organizations of today. From these perspectives, this research has identified three major areas of application of new

technologies in manufacturing organizations. They are classified as technical, management and environment areas respectively.

The first area is concerned with technical operations at shop floor. Applications at this level involve more analytical and numerical computation than perceptual problem-solving tasks (Nobre, 2008). This level demands high degrees of cognition, intelligence and autonomy from individual machines as well as from groups of machines since they need to provide the organization with high degrees of flexibility and agility. For these conditions, cognitive machines play an important part since they are designed to participate in the organization by fulfilling roles that also satisfy such requirements.

The second area is concerned with management. Applications at this level also involve analytical and numerical computation, but they demand more abilities for manipulation of percepts and natural (fuzzy) concepts. For this reason, cognitive machines play a more distinguished task in this area of management since they also have the ability to manipulate a percept and natural concepts in the form of words and sentences of natural language (Nobre, 2008; Nobreet *al.*, 2009b). Applications at this level demands high degrees of cognition, intelligence and autonomy from Information Management Systems (IMS) for the coordination of individual machines and groups of machines. For this purpose, Cognitive Information Systems (CIS) will play an important part in the management of the whole manufacturing enterprise (Nobreet *al.*, 2008, 2009a, 2010a).

The third area of application is less obvious and less present in the organizations of today. It is concerned with the management of the environment by the organization. However, and most importantly, it demands a more efficient and effective manner to connect the organization with the environment in order to exchange information resources. In this view, immersiveness will play an important task by connecting customers into the organization.

3.2. Management Perspective

From Past to Present: There was a time in the past when manufacturers used to interact with their customers in a personal way. It was a human to human interaction. Every customer had a distinguished treatment and their specific needs of services and goods could be captured and produced by the manufacturer. In such a way, manufacturers were able to learn and to evolve with their customers. That was a craftsman era.

With the Industrial Revolution, there was a gradual emergence of modern organizations. These organizations were challenged by new political, economic, social and technological contexts that paved developments and innovations in management areas which were necessary to support new business and production models. Such innovations were necessary to provide organizations with the capability to manage higher levels of environmental complexity. Among such advancements there was the concept and the practice of Mass Production System (MPS) which emerged in the beginning of the 20th century. The purpose of MPS was to provide manufacturers with a set of managerial processes and technologies

capable to produce higher volumes of products and to reach a broader market than any other previous production model. At that time, special attention and contributions were received from the school of scientific management, and thus by the studies proposed by Frederic Taylor (1911). The practices of MPS were put in action by Henry Ford still in the beginning of the 20th century. From the scientific management principles, the activities of managers and workers at shop floor were pragmatically separated, defined and rationalized. Interchangeable components and standardized products, manufactured with minimal cost for mass markets, were some of the strategies adopted for that period.

The gradual transition which occurred during the 20th century, moving attention from mass production towards a new model characterized by the production of versatile products in smaller numbers, marked the line that established what is known today as Batch Production Systems (BPS). BPS offers some level of customization, and thus it provides the organization with capabilities to produce more variety of products than previous approaches. Batch production models were the levers for the study of both flexible (Toni & Tonchia, 1998) and agile (Lee, 1998) manufacturing systems, and they were supported by the concepts of integrated and cellular manufacturing, Just-In-Time (JIT), statistical sampling and Total Quality Control (TQC). This latter (TQS) emerged around the 1940's in the United States of America from the progresses made by the American Society for Quality Control (ASQC), and later it was put in action by Japanese organizations and the Japanese Union of Scientists and Engineers (JUSE).

Batch Production Systems (BPS) arose to give more attention to market diversification and also to manage customers' satisfaction and relationships. In such a model, satisfaction is supposed to be achieved by giving customers with a more diversified class of products whose characteristics can be closer to their expectations and exact needs; and consequently, relationships between the organization and customers could be developed and retained according to improvements in customers' satisfaction. These premises were the preliminary motivations to empower the concept of Mass Customization Systems (MCS), which denote a business model that are supposed to offer any customer with goods or services that have been pre-designed (customized) to fit a customer's exact needs (Pine, 1999). In such a way, MCS combines the best practices of the craftsman era with principles of mass production.

Mass Customization Systems (MCS) provides organizations with better capabilities to manage customers' satisfaction and relationships, and therefore it improves the organization's competitive advantages. Nevertheless, the model of MCS puts forward new challenges for organizations.

Managerial Limitations: The continuous growth in the level of environmental complexity has also been demanding organizations to search for new management solutions and new organizing models. The migration from mass and batch production models to Mass Customization Systems (MCS) is among such innovations. However, such a movement has been introducing new challenges for organizations. The need to manage higher levels of customization along with a more intensive customer relationship approach has challenged organizations with more complex task environments. The pursuit of higher levels of customization, in order to cope with higher levels of environmental complexity, has grown in such a way that the capability of current manufacturing organizations to deal with such levels of uncertainty has been reaching a threshold since the current and dominant managerial state of the art

has been finding its limits of contribution. For this reason, new management approaches and organizing models have been emerging to complement the past and current ones, and also to extend the cognitive capabilities of the organization when operating in environments of higher levels of complexity. The incompatibility, and the non-equilibrium, between the higher level of environmental complexity and the insufficient capabilities of current and dominant management systems has been motivating the gradual transition from production models of manufacturing organizations of today to the new features of Customer-Centric Systems (CCS).

The Management Threshold Principle: The continuous growth in the level of environmental complexity demands from the organization the pursuit of continuous growth in the level of customization. This dependence will reach a threshold where customers will be part of the design, production, and management of their own needs, resulting in the generation of highly personalized and customized services and goods.

From Present to Future - New Managerial Core Competencies of CCS: Therefore, to evolve to a more complex task environment, besides higher degrees of flexibility and agility, the manufacturing organization has to present the capability to interact with its customers by capturing their particular needs, resulting in the production of their goods and services according to their requirements. Organizational learning, competitive advantage and value chain processes, along with customer relationship and supply chain management will play an increasing and important part with such new Customer-Centric Systems. Therefore, more attention will be necessary for the management of the organization environment, by considering for example the management of customers' requirements and needs, the coordination of supply chain and inter-organizational networks, along with the creation of sustainable values (Hart & Milstein, 2003) The Capability Maturity Model Integration (CMMI) for Systems Engineering, Software Engineering, Integrated Product and Process Development, and Supplier Sourcing, as proposed by the Software Engineering Institute of the Carnegie Mellon University (CMU-SEI, 2002), appears as a powerful model constituted by a set of guidelines for organization process improvement which can be useful to manage processes and technological trends in the new organizational production system.

3.3. Organizational Systems Theory Perspective

From Past to Present: Schools of organizations and management were developed in order to support the analysis and design of new organizing systems. Such schools emerged from the first decade of the 20th century, giving rise and maturation to the discipline of organization theory (Khandwalla, 1977; March, 1965; Scott, 1998). They started with theories of bureaucracy, principles of scientific management and administrative theory, and they received new insights from the experiments of the human relations school (Pugh, 1997). Important developments and new contributions to organizations were provided by the schools of administrative behavior and decision-making (Cyert & March, 1963; March & Simon, 1993; Simon, 1997a, 1997b), systems theory (Silverman, 1970), socio-technical systems (Trist, 1981), contingency theory (Galbraith, 1973, 1977), organizational learning (Argote, 2007; Dierkes *et al.*, 2003),

Computational Organizational Theory (COT) (Carley& Gasser, 1999), knowledge management (Nonaka, 2005), strategic management (Hitt, Ireland & Hoskisson, 2008), among others. This section gives more attention to the school of systems theory because it uses the concepts of hierarchic levels of complexity, as proposed in (Boulding, 1956; Simon, 1996), to derive analyses and conclusions about the evolution and developments in manufacturing organizations.

The analysis of organizations as cybernetic systems received its first contribution after Norbert Wiener's work (Wiener, 1948). Such systems present the capability of self-regulation in terms of some externally prescribed target or criterion (Boulding, 1956), and they are suitable for the analysis of any type of organizations, including manufacturing systems. Self-regulation means the ability of a system to maintain its steady states by sensing and by responding to its environment. Self-regulating systems encompass processes which work according to some artificial or natural law of behavior, and they are supported by the principle of feedback. Therefore, they have a fundamental task in control theory, and thus in management control of organizational processes (Anthony, 1984), administrative decision-making (Simon, 1982), organization design (Haberstroh, 1965; Galbraith, 2002), and adaptive learning cycles of learning organizations (Daft & Noe, 2001). Nevertheless, organizations and manufacturing can also be analyzed according to the operations and properties of systems of higher levels of complexity than cybernetics. Examples include open and social systems (Scott, 1998).

Organizational Limitations: The increasing need of the organization to manage higher levels of environmental complexity has demanded higher degrees of organizational cognition. Therefore, new organizing models, practices and organizational theories have been developed in order to support improvements in the capability of the organization for information processing and uncertainty management (Nobreet *al.*, 2009a). This context motivates the gradual transition from production models of manufacturing organizations of today to the new features of Customer-Centric Systems (CCS).

The Organizational Threshold Principle: The continuous growth in the level of environmental complexity demands from the organization the pursuit of higher degrees of organizational cognition. This dependence will reach a threshold where current and dominant models of organizing will found their limits of contribution.

From Present to Future - New Organizational Core Competencies of CCS: This paper proposes that differences in the levels of complexity of systems reside not only in the properties and structure of their elements, but most importantly, in the abilities of these elements. The former, i.e., properties and structure, refers to physical, biological and chemical attributes of the system, and the latter, i.e., abilities, means cognition, intelligence and autonomy of the system. Therefore, by analyzing the Boulding's typology (Boulding, 1956) that classifies systems according to their levels of complexity, it becomes evident to conclude that the higher the complexity of a system in the Boulding's classification scale, the higher is its degree of cognition, intelligence and autonomy (Nobreet *al.*, 2009a). This classification of Boulding's systems in the order of growth of their levels of complexity is given by frameworks, clockworks, cybernetic systems, open systems, blueprinted-growth systems, internal-image systems, symbol-processing systems, social systems, and transcendental systems. Therefore, moving in

this continuous scale of complexity, systems grows towards higher degrees of cognition, intelligence and autonomy. In this perspective, Customer-Centric Systems (CCS) represents a model of higher level of complexity than organizations of the present.

4. Findings of the new Organization

Figure 3 illustrates the Technological, Management and Organizational Threshold Principles where the threshold line symbolizes the frontier between batch production and Customer-Centric Systems. In such a transition, organizations move towards higher degrees of flexibility and agility, higher degrees of cognition, intelligence and autonomy, and also higher levels of customization along with higher capabilities of mass customization.

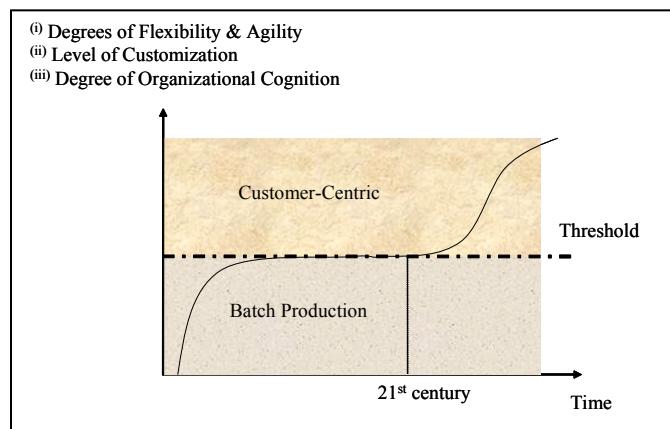


Figure 3. The Technological (i), Management (ii) and Organizational (iii) Threshold Principles

(source: author)

Figure 4 illustrates the convergence of Mass Production Systems (MMS) and Batch Production Systems (BPS) towards Customer-Centric Systems (CCS) under the three complementary perspectives. In such a convergence, the term technological cognition is synonymous with degrees of cognition of machines and organizations, and it is also associated with degrees of flexibility and agility. Therefore, in this context it becomes plausible to assert that the higher the degree of cognition of a system (which subsumes humans, machines and organizations), the higher is its degree of agility and flexibility. The CCS model is also characterized by higher levels of customization and higher levels of customer satisfaction. It can be observed that the migration of the organization from mass and batch production to the CCS goes towards the values of the Customer Relationship Management (CRM) paradigm (Brown, 2000),

which is motivated in part by the human aspects provided by the craftsman era. In essence, the CRM strategy is concerned with the attraction, acquisition, retention and satisfaction of customers.

Still observing Figure 4, it can be stated that the levels of complexity of manufacturing organizations and their respective environments evolves as we move from levels 1 to level 3. These three levels are not mutually exclusive. Indeed, each higher level system incorporates the features of those below it. In level 1, the system structure is highly rigid, more constrained and limited. As we progress from level 1 to 3, the system structure becomes somewhat less constrained and the connections among the interacting parts become relatively loose, where less constraint is placed on the behavior of one element by the condition of the others; the manufacturing organization and its environment becomes more interdependent, and therefore, the evolving of one affects the other. Additionally, according to the concept of Hierarchic Levels of Cognition (Nobreet *al.*, 2009a, 2009b), this paper asserts that the degrees of cognition of these systems and of their elements increase as we move from levels 1 to 3. Consequently, there is also growth in their degrees of intelligence, autonomy, flexibility and agility.

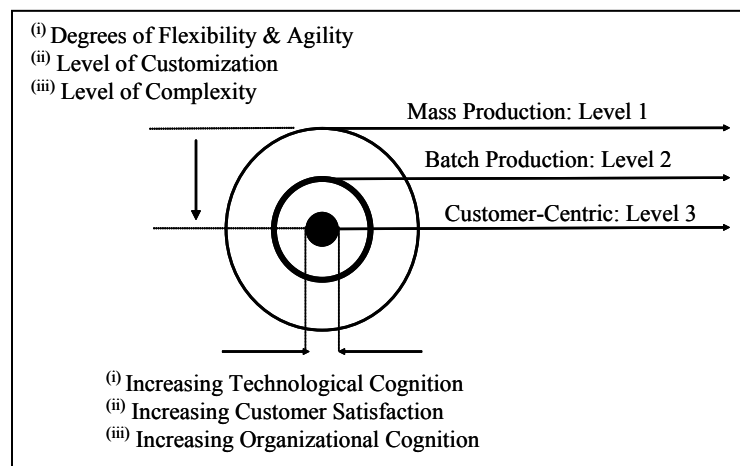


Figure 4. Convergence from MPS and BPS towards CCS

(source: author)

Therefore, from all these analyses, it is plausible to assert that:

- (i) The higher the level of customization of the manufacturing organization, the higher is the level of (task) environmental complexity. This statement is also based on Lawrence & Lorsch's studies on contingency theory (Lawrence, 2000; Lawrence & Lorsch, 1967). It is concerned with the level of environmental complexity that the manufacturing organization has to deal with in order to

complete tasks, to control production demand, and to manage customers, supply-chain, along with its core elements of technology, social structure, goals and participants.

- (ii) The higher the level of (task) environmental complexity, the higher is the degree of organizational cognition needed in order to process information, to manage uncertainties and knowledge.

These statements associate the pursuit of organizational cognition with the new levels of environmental complexity.

Table 1 summarizes the technological, management and organizational systems perspectives of manufacturing organizations, where the dotted arrow points out the direction of higher degrees of technological cognition, higher levels of customization, and higher degrees of organizational cognition. The abbreviations SC, FS, CTP, VR, AT, DAI and COT indicate Soft Computing, Fuzzy Systems, and Computational Theory of Perceptions (Zadeh, 1973, 1994, 1999, 2001), Virtual Reality, Agent Technology, Distributed Artificial Intelligence, and Computational Organization Theory (Bradshaw, 1997; Carley& Gasser, 1999), respectively. This paper asserts that such disciplines give fundamental basis for the design of the new technologies of Customer-Centric Systems.

Table 1. Evolution of the Perspectives of Industrial Organizations

(source: author)

Levels of Customization	Technological Principles	Management Principles	Organizational Principles
Mass Production: Level 1	Manual and Single Purpose Machines. (Pneumatic Tools and Analogue Machinery).	Interchangeable components, standardized products, minimal cost and mass markets (Scientific Management Principles)	Rational Systems with: Static, rigid and constrained structures; low levels of environmental complexity and interaction.
Batch Production: Level 2	Programmable Systems Computer Integrated and Flexible Manufacturing Systems (Information Technology Systems).	Versatile products in smaller quantities (Integrated and Cellular Manufacturing, Just in Time, Statistical Sampling and Total Quality Control).	Cybernetics Systems with: Time-varying parameters and non-linear structures, capability of self-regulation; and medium levels of environmental complexity and interdependence.
Customer-Centric: Level 3	Cognitive Machines, Cognitive Information Systems, Immersiveness, Agile and Flexible Machinery and Management Systems (SC, FS, CTP, VR, AT, DAI, COT and Internet).	Higher levels of customization, mass customization capability, management of the environment, focuses on customers and competitors (Organizational Learning, Competitive Advantage and Value Chain Processes, Supply Chain and Customer Relationship Management, Sustainable Values, and CMMI Model).	Open, Knowledge and Learning Systems with: High levels of environmental complexity and interdependence, high degree of organizational cognition, capability of self-maintenance and sustainable development, loosely connected parts with high degrees of flexibility and agility; capability to form organizational networks.

The next section demonstrates the application of some of the new features of Customer-Centric Systems and it enhances the roles of cognitive machines, Cognitive Information Systems (CIS) along with the concept of immersiveness in the new Computational Organization Management Networks (COMN).

5. Computational Organization Management Networks (COMN)

This section introduces a new kind of organization that implements the main features of Customer-Centric Systems. It contributes by presenting the definition, the structure and the processes of Computational Organization Management Networks (COMN) as proposed in (Nobreet *al.*, 2009a). COMN are new organizations whose principles of operation are based on the concepts of Hierarchic Cognitive Systems (Nobre, 2008) along with those of Telecommunications Management Networks (ITU-T, 2000). Structured with functional layers and cognitive roles which range from technical and managerial to institutional levels of analysis, and also equipped with operational, managerial and strategic processes, the concept of Computational Organization Management Networks (COMN) plays an important part in the developments of future organizations where cognitive machines and Cognitive Information Systems (CIS) are prominent actors of governance, automation and control of the whole enterprise. Moreover, this section introduces the concept of immersive systems in order to provide the new organization with the capability of immersiveness.

Steps in the Creation of the New Organization

The creation of COMN requires intensive investments in information technology, artificial intelligence and knowledge management systems. This section shows the steps of design of such new organizations.

Nevertheless, COMN is necessary if we want to continue following the current model of economic production and society in which we live in; whereas such a model is characterized by egocentrism, individualism and a high degree of consumerism; and whereas our cultural alienation and dependence of the intensive materialism has been driven and empowered by an economic model of maximizing production and consumption which, in turn, has leading to the minimization of the environmental resources and a deterioration in values and social conditions of mankind.

5.1. The Scope of the New Organization

Computational Organization Management Networks (COMN) fall in the class of organizations that pursue high degrees of organizational cognition, intelligence and autonomy, and consequently, high degrees of agility and flexibility, in order to manage high levels of environmental complexity, to operate through intensive mass customization, and to provide customers with immersiveness (Nobreet *al.*, 2008, 2009a).

This paper advocates that such a kind of new organization has to be equipped with high levels of automation in order to pursue the necessary capabilities to govern, to coordinate and to control cognitive tasks of technical, managerial and institutional levels in the whole enterprise. Hence, it focuses attention to the conception of organizations of this type.

5.2. Cognitive Information Systems (CIS)

This is into such a domain and perspective of the new organization that this research concentrates efforts to design information management systems with high degrees of cognition, intelligence and autonomy. These systems are hereafter called Cognitive Information Systems (CIS); whereas CIS are Knowledge Management Systems (KMS) that pursue high degrees of cognition, intelligence and autonomy. They are particular classes of cognitive machines, and they are designed to participate in the organization by performing cognitive tasks of all levels and by fulfilling managerial roles in all the layers of the whole enterprise (Nobreet *al.*, 2008, 2009a, 2010a).

5.3. Participation of CIS in the Organization

Cognitive Information Systems (CIS) participate in the organization by performing cognitive tasks and by fulfilling roles of technical, managerial, and institutional levels. From this point of view, this paper identifies four major areas of CIS application in the whole enterprise. These areas are classified into four organizational layers:

- a) Element Layer: The Operational Level.
- b) Network Management Layer: The Primary Managerial Level.
- c) Service Management Layer: The Secondary Managerial Level.
- d) Business Layer: The Strategic Level.

5.4. Functional Layers of the New Organization: Steps of Creation

Functional layers play the fundamental part in the definition of the structure and processes for the new organization of COMN. Their concepts are based on the definition of Hierarchic Cognitive Systems (HCS) as introduced in (Nobre, 2008) along with the principles of Telecommunications Management Networks (TMN) architectures which have been proposed by International Telecommunication Union (ITU-T); where ITU-T is the designation of the United Nations Specialized Agency in the field of telecommunications (ITU-T, 2000). In the organizational architectures of TMN, agents execute tasks in all hierarchical layers of the organization. Similarly, agent technology (Bradshaw, 1997; Watt, 1997) plays

important tasks in the functional layers of the new organization of COMN; where in this paper, agents are also synonymous with cognitive machines and Cognitive Information Systems (CIS).

This subsection proposes four functional layers for the new organization. It also introduces the roles of the agents that participate in the COMN by governing, controlling and coordinating cognitive tasks of all levels in all the layers of the whole enterprise.

Step 1 - CIS in the Element Layer: The Operational Level

The Element Layer (EL) comprises a Network Element Layer (NEL) and an Element Network Layer (ENL). The former part (NEL) comprises functional elements that work upon an individual basis, and, therefore, each individual element carries its own motives and fulfils micro-roles. The latter part (ENL) comprises a set of interconnected functional elements that work in group, and, therefore, they carry common motives and sub-goals, and they also fulfill micro-roles. In this kind of organization, an element is synonymous with an agent, and an agent is synonymous with a cognitive machine; and thus, a group of interconnected elements is synonymous with a group of agents that has the same meaning of a group of interconnected cognitive machines. Figure 5 illustrates the two parts of an Element Layer (EL), where $a_{(1...n)}$ denotes agents, for n integer.

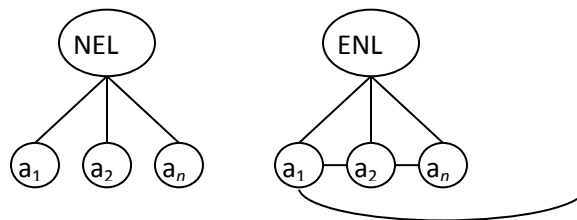


Figure 5. NEL as a controller of individual agents $a_{(1...n)}$ and

ENL as a controller of a group of integrated agents

(source: author)

The roles of Cognitive Information Systems (CIS) in the Element Layer (EL) are concerned with the execution of cognitive tasks for operation, control and coordination of individual elements as well as of groups of interconnected elements. These elements, as individuals and groups, participate in the whole organization by performing cognitive tasks of technical, managerial, and institutional levels. Therefore, in this particular case, the CIS provide operational, control and coordinative processes to individual agents and group of agents that participate in the organization.

The Element Layer (EL) demands high degrees of cognition, intelligence and autonomy from the individual machines as well as from the groups of machines. For these requests, the technology of cognitive machines, along with the methodologies of Soft Computing (SC) (Zadeh, 1994), Fuzzy Logic (FL) (Zadeh, 1973), Computing with Words (CW) (Zadeh, 1999), and Computational Theory of Perceptions (CTP) (Zadeh, 2001), play an important part in the conception of Cognitive Information Systems (CIS).

Applications at the level of Element Layer (EL) have received some attention, for instance, by researchers who have developed information and decision-support systems for manufacturing operations through the background of fuzzy logic, neural networks and genetic algorithms (Kusiak, 2000; Monfared& Steiner, 1997; Rao *et al.*, 1993; Wu, 1994). Nevertheless, despite achieving some successful results, these managerial and decision-support tools of mathematical and computational background have been constrained by the limitations of cognition, intelligence and autonomy of the existing machines which are mostly encountered in the organizations of today. The application of these machines in Flexible Manufacturing Cells and Systems (FMS) and their coordination through Computer Integrated Manufacturing (CIM) technology, have reached thresholds and limitations of contributions because of their insufficient degrees of cognition, intelligence and autonomy (Nobreet *et al.*, 2009a).

Step 2 - CIS in the Network Management Layer: The Primary Managerial Level

The united work of individual agents and groups of agents in the Element Layer (EL) forms a set of patterns or clusters which represent the main macro-roles in the organization. Each pattern or cluster is synonymous with a functional network.

The Network Management Layer (NML) comprises the set of individual functional networks in the organization; and it is equipped with an organizing system constituted by normative structure, processes, technologies, agents and sub-goals, in order to provide management to each functional network upon an individual basis. Therefore, the NML provides the individual functional networks of the organization with coordination, control and management of processes, operations and information that flows through the clusters of agents and groups of agents that participate in the whole enterprise. Figure 6 illustrates a NML managing individual Functional Networks $FN_{(1...m)}$, for m integer.

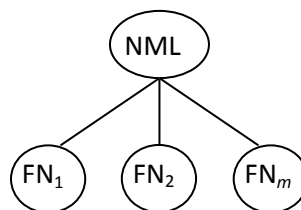


Figure 6. NML as the manager of individual $FN_{(1...m)}$

(source: author)

The roles of Cognitive Information Systems (CIS) in the Network Management Layer (NML) is concerned with the effective and efficient use of the NML's organizing system resources in order to execute cognitive tasks for coordination, control and management of the functional networks upon an individual basis; where, in this case, a functional network is synonymous with a network of agents and also with a network of cognitive machines. In such a perspective, functional networks (and thus networks of cognitive machines) participate in the organization by performing cognitive tasks of technical, managerial and institutional levels; and they fulfill operational, management and strategic roles in the whole enterprise.

It is important to emphasize that while Cognitive Information Systems (CIS) participate in the Network Management Layer (NML) by managing each individual functional network in the organization, they participate in the Element Layer (EL) by operating and controlling individual agents and groups of agents that participate in the functional networks of the organization. Therefore, the NML comprises the management of the EL in the organization.

The performance of managerial roles in the organization is contingent upon the capabilities of the managers and also upon the capabilities of the individuals and groups that the managers supervise. Therefore, it can be stated that the higher the degree of cognition of Cognitive Information Systems (CIS), the higher is their capability to manage Functional Networks (FN) in the organization; and that the higher the degree of cognition of the elements of a Functional Network (FN), the higher is the capability of CIS to manage the FN.

Step 3 - CIS in the Service Management Layer: The Secondary Managerial Level

The set of functional networks in the organization forms vertical and horizontal processes and involves sub-goals and goals, where sub-goals represent means for the achievement of more complex goals. Therefore, a managerial system is needed in order to coordinate, to control and to mediate all the operations, processes and information that flow between the functional networks in the organization.

The Service Management Layer (SML) comprises the set of functional networks in the organization; and it is equipped with an organizing system constituted by normative structure, processes, technologies, agents, goals and sub-goals, in order to provide management for the set of functional networks. Therefore, the SML provides the organization with a managerial system with the capability to coordinate, to control, to integrate, and to mediate all the operations, processes and information that flows between the functional networks in the whole enterprise. Figure7 illustrates an SML managing a set of integrated Functional Networks $FN_{(1...m)}$

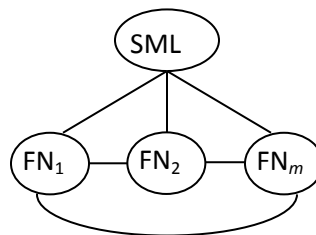


Figure 7. SML as the manager of integrated $FN_{(1...m)}$

(source: author)

The roles of Cognitive Information Systems (CIS) in the Service Management Layer (SML) is concerned with the effective and efficient use of the SML's organizing system resources in order to execute cognitive tasks of integration, coordination, control and thus management of the relations, operations, processes and information that flows through and between the functional networks in the organization; where, in this case, the set of functional networks is synonymous with the set of networks of agents and consequently with the set of networks of cognitive machines in the organization. Into such a domain,

each functional network can be synonymous with a cluster of services, or in short, a service. Therefore, the Cognitive Information Systems (CIS) in the Service Management Layer (SML) can also be viewed as agents of management of the whole services in the organization.

It is important to emphasize that while CIS participate in the Service Management Layer (SML) by managing the operations, processes and information between all the functional networks in the organization, they participate in the Network Management Layer (NML) by managing each functional network upon an individual basis. Therefore, the SML comprises the management of the NML in the organization.

Applications at the SML and NML have received some contributions with the advances in Enterprise Resources Planning and Management Systems (EPR) that emerged from the 1970's. ERP are classes of information technology and management systems which are applied to, and implemented in the whole organization with the purposes of integration, control and automation of data, information and processes. Examples of areas of application of ERP systems include: Manufacturing, Supply Chain, Financials, Customer Relationship Management (CRM), Human Resources, Warehouse Management and Decision Support System. Applications in the level of the Service Management Layer (SML) will receive greater contributions in the proportion of the continuous advancements in Cognitive Information Systems (CIS) of high degrees of cognition, intelligence and autonomy; and thus CIS will play an important role in the SML of new organizations.

Step 4 - CIS in the Business Management Layer: The Strategic Level

The Business Management Layer (BML) comprises all the operations, management processes, strategies and services of the previous layers, i.e. the EL, NML and SML respectively; and it is equipped with an organizing system constituted by normative structure, processes, technologies, agents and goals, in order to provide the organization with capabilities to manage the environment. More specifically, the BML provides the enterprise with a managerial system with the capability to coordinate, to control and to mediate the operations, processes and information between the organization and the environment. Figure 8 illustrates the role of the BML in the organization.

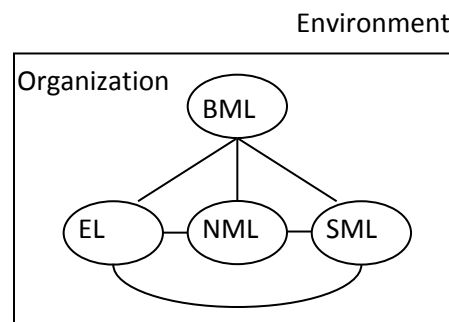


Figure 8. BML as the manager that mediates between the organization and the environment

(source: author)

The roles of Cognitive Information Systems (CIS) in the Business Management Layer (BML) are less obvious and less present in the organizations of today. It is concerned with the effective and efficient use of the BML's organizing system resources in order to execute cognitive tasks for coordination, control and thus management of the relations, operations, processes and information in between the organization and the environment. To enhance this application, this paper proposes the concept of immersiveness whose idea was first spoken in (Nobre& Steiner, 2002), and further developed in (Nobreet *al.*, 2009a).

5.5. The Concept of Immersiveness

It was stated in this research that organizations have to be equipped with structure, processes, goals, agents and technologies which are able to provide them with the capability to pursue high levels of immersiveness; whereas immersiveness represents the ability of the organization to interact with agents of the market (either humans or machines) in a friendly way, by immersing them into the organization's operations through approaches such as virtual reality, simulation or via real world protocols; and it aims to satisfy customers by capturing their exact needs, by customizing and managing the design, engineering and production of their goods and services, and by delivering their products with efficacy and efficiency.

More specifically, either manufacturing or service organizations, they can immerse their customers by providing them with the scope to interact with some of the life cycle stages of their processes of design, engineering and production, including those processes of requirements analysis, product design, test, prototyping, demand specification, volume and variety choice. Under this perspective, virtual reality will play an important task in the customer immersiveness; the technologies of cognitive information systems and cognitive machines will provide important contributions in the execution of cognitive tasks such as pattern recognition and vision, natural language processing, decision-making, problem-solving, learning, and management; additionally, the internet will play an important part in the connection of customers into the new organization. This perspective is illustrated in Figure 9 and it is assumed that such an illustrative immersive system can be configured to provide customers with different levels of acces and interaction to the technical and managerial operations of the processes of design, engineering and production in the organization. The dotted lines symbolize the internet which connects customers within the organization; and the continuous lines denote the system operational levels that clients can interact with, in order to capture customers' exact needs and even emotions, to customize and to manage the design, engineering and production of their goods and service

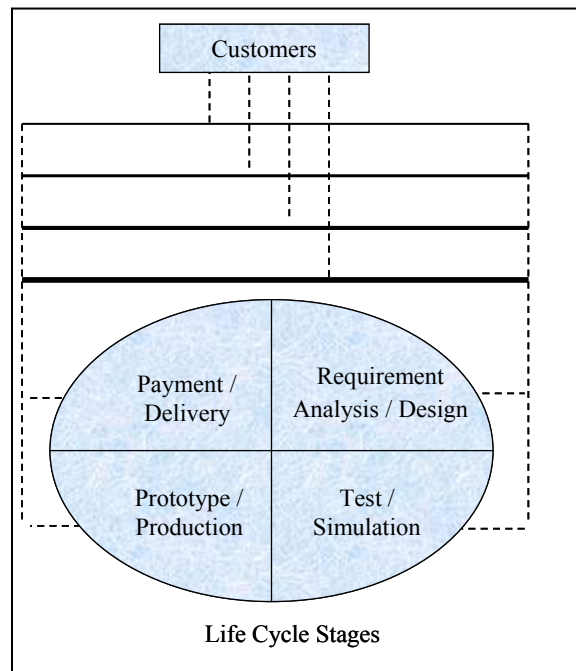


Figure 9. Illustration of an Immersive System

(source: author)

5.6. Definition of COMN

Computational Organization Management Networks (COMN) are organizations whose structure, processes, participants, goals and technologies are designed according to the concepts of Functional Layers which include Element Layer, Network Management Layer, Service Management Layer and Business Management Layer. COMN pursue high degrees of organizational cognition and their main participants subsume Cognitive Information Systems (CIS) and cognitive machines.

5.7. Structure and Processes of COMN

Figure 10 illustrates the structure of Computational Organization Management Networks (COMN) which is composed by Element Layer (EL), Network Management Layer (NML), Service Management Layer (SML) and Business Management Layer (BML) respectively.

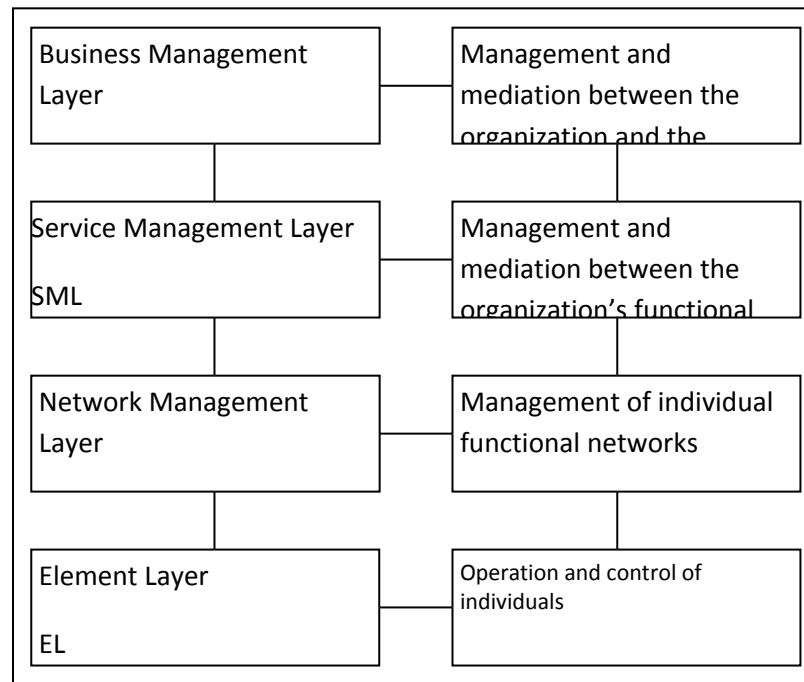


Figure 10. Structure of Computational Organization Management Networks (COMN)

(source: author)

6. Conclusions

This paper analyzed past and current manufacturing organizations through three complementary perspectives of technology, management and organizational systems theory. It was found that the convergence of manufacturing organizations to the new features of Customer-Centric Systems (CCS) is contingent upon the continuous growth in the level of environmental complexity. It emphasized that CCS configures the new technological, managerial and organizational faces which industrial organizations need to have if they want to manage higher levels of environmental complexity in the 21st century.

The contributions proposed in this research were motivated by the principle of incompatibility, and the non-equilibrium state, existing between the continuous growths in the level of environmental complexity and the insufficient cognitive capacity of current manufacturing organizations. Therefore, this paper focused on the general picture of organizations pursuing high degrees of cognition in order to improve their capabilities for information processing and uncertainty management. It assumed that

improvements in the degree of organizational cognition can lead the organization to achieve higher degrees of flexibility and agility, to operate through higher levels of mass customization, and to provide customers with immersiveness. In its broader sense, it assumed that such improvements can extend the capability of the organization to manage higher levels of environmental complexity. Into such a context, this paper contributed by analyzing threshold capabilities of old and current manufacturing systems and by proposing new technological, managerial and organizational features for future manufacturing organizations. For such a purpose, it proposed the concepts of Customer-Centric Systems (CCS) and Computational Organizational Management Networks (COMN). COMN are new computational organizing models with the capability to implement the features of CCS.

Cognitive machines are agents of organizational cognition and they contribute to improve the degree of cognition of the organization. Consequently, improvement in the degree of organizational cognition contributes to reduce the level of environmental complexity and uncertainty that the organization needs to manage.

Computational Organization Management Networks (COMN) implements the new features of Customer-Centric Systems. COMN are organizations whose structure, processes, participants, goals and technologies are designed according to the concepts of Functional Layers which comprise Element Layer, Network Management Layer, Service Management Layer and Business Management Layer. COMN pursue high degrees of organizational cognition and their main participants comprise Cognitive Information Systems (CIS) and cognitive machines.

Such a kind of new enterprise will play a fundamental part in the processes of engineering, production, logistics and management of goods and services along with the processes of management of transactions, business and electronic commerce in the future organizations and markets. According to Nobreet *al.* (2009a), COMN will be legally supported with nexus of contracts that assign the responsibilities to, and define agreements between, the organization and the designer of the cognitive machines (and cognitive information systems) which are the main participants in the layers of the whole organization. The roles of these new participants will be defined in the normative structure of the organization.

The creation of COMN requires intensive investments in information technology, artificial intelligence and knowledge management systems. This paper shows the steps of design of such new organizations.

Nevertheless, COMN is necessary if we want to continue following the current model of economic production and society in which we live in; whereas such a model is characterized by egocentrism, individualism and a high degree of consumerism; and whereas our cultural alienation and dependence of the intensive materialism has been driven and empowered by an economic model of maximizing production and consumption which, in turn, has leading to the minimization of the environmental resources and a deterioration in values and social conditions of mankind.

6.1. Further Extensions

On Cognitive Machines and Emotions: The topic of machines with emotions and emotional processes in organizations was left for further research. However, it deserves some comments due to its importance in the literature. Whether machines should exhibit emotional behavior, and whether they are able to have emotions or not, are controversial topics among the researchers of artificial intelligence, cognition and social sciences.

By assuming that machines may indeed be able to have emotional processes and emotional behavior, the question of whether emotions are important to machines or not depends on the motivations of their designers and upon the environment with which they relate. On the one hand, machines with emotions, or emotional machines, might form better relations and social networks with humans in organizations than other machines. In such a view, machine emotion would be relevant for researchers on organizational behavior. On the other hand, machines with emotions might have their own motives and might represent additional agents of dysfunctional conflicts in organizations. In such a view, machine emotion would be a problem for researchers of rational theories. Among the institutions which have been researching the field of emotional machines include The MIT Artificial Intelligence Laboratory at Massachusetts (Breazeal, 2000).

On Cognitive Machines vs. Humans in Organizations: Are cognitive machines better agents of organizational cognition and organizational learning than humans? Are they better agents of organization performance and productivity than humans? Such questions rely on the statement that: - if we assume that the cognitive roles in organizations have performance and outcomes which can be attributed to either humans or machines, without any distinction, then we are ready to consider machines as participants within the organization similarly to people. This perspective involves a rational comparison between machines and human's performance if we assume that they compete for the same roles in the organization. Such questions need to be further investigated in order to derive conclusions about the economic, political, social and technological implications of cognitive machines for the society.

6.3. Challenges and the future of the industrial organization

While the characteristics of the elements of the organization will change, evolve and develop continuously towards higher levels of cognition and complexity, the purpose of existence of the organization will remain the same or will not change in the same proportion of its elements (Nobreet *al.*, 2009a). The former part, which is concerned with the elements of the organization, will move towards high levels of automation, and it will include machines with high degrees of cognition, mainly in those areas at upper layers and levels of the organization; and thus they will provide organizations with more capabilities of computational capacity along with knowledge and uncertainty management. Therefore, new organizations of this kind will be able to operate in, and to manage higher levels of environmental complexity and uncertainty than organizations of today. These transformations towards new organizations will have implications for the society and this is a topic of further research (Nobreet *al.*,

2008, 2009a, 2009b). The latter part, which is concerned with the purpose and the existence of organizations, will remain the same and for sure will not change in the same proportions to the evolutions in the organization elements. This is because the individual motives and the organizational goals which are pursued by human kind will not change over time into the political, economical and social facets of this society.

It is in such a context of production that organizations and their participants will be challenged to decide on whether they are ready to create competitive advantage without affecting the balance and equilibrium of such a triad. It raises the question about the endurance and survival of the human species.

One day, perhaps not so far in the 21st century, worldwide organizations and their executives will have the ability to perceive, to sense, to decide and to act based on new models of organizing and management thought which are grounded in concepts of systemic sustainability; whereas these new models should require the reconciliation of environmental, social and economic demands - the "three pillars" of sustainability (Nobreet *al.*, 2011). It is in such a new context that organizations and their participants will be challenged to decide on whether they are ready to create competitive advantage without affecting the balance and equilibrium of such a triad. It raises the question about the endurance and survival of the human species.

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