Organizational Learning:
Control Systems and Routines

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Author Contributions.

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✝ To the memory of Carlotta, who died in a car accident on January 11, 2015.

ABSTRACT (Piero Mella)

As *cognitive control systems*, organizations carry out a *cognitive activity* involved in giving "meaning" to environmental stimuli, translating these into information and structuring these as knowledge, thereby developing a pro-active behavior for the long-term reproduction of the economic processes, anticipating environmental changes. Improving this approach, I argue that organizational *attention* to an issue raises and develops when an organization prioritizes that issue. Any organization develops a "pattern of organizational attention", focusing on particular issues, given a particular configuration of skills, plans, and procedures, to determine which levers of control to activate to reach defined policy goals. Organizational moves are the result of an attentional decision-making process and become part of the organization's environment of decision and influence, from a feedback perspective. I then show how and why *attention*, linked to control systems, is the driving force of organizational knowledge creation and development to demonstrate how the development of knowledge and individual attention could be the premise for a more complete *organizational learning*. The faster the organization learns how to develop *attention* and *thinking*, the more ready the entire organization will be to deal with external dynamics. Lastly, I go further and consider the recent literature on knowledge creation and routines as a development of organizational theories, demonstrating that there is strong evidence for progress in cognition, attention, learning, and intelligence. Intelligence occurs when organizational knowledge creation is continuous and seen as a circular process not confined to the organization but one that includes many interfaces with the environment. From this perspective, organizations are "ideal repositories" for "tacit knowledge accumulation", much of which is expressed by routines.

In quanto *sistemi di controllo cognitivi*, le organizzazioni svolgono un'*attività cognitiva* che consiste nel dare "significato" agli stimoli ambientali, traducendoli in informazioni e strutturandoli come conoscenza, sviluppando così un comportamento proattivo per la riproduzione a lungo termine dei processi economici, anticipando i cambiamenti ambientali. Migliorando questo approccio, ho sostenuto che l'*attenzione* dell'organizzazione a un problema sorge e si sviluppa quando un'organizzazione dà la priorità a quel problema. Ogni organizzazione sviluppa un "modello di attenzione organizzativa", focalizzandosi su temi particolari, data una particolare configurazione di competenze, piani e procedure, e determinando quali leve di controllo attivare per raggiungere una definita politica di obiettivi. Le mosse organizzative sono il risultato di un processo decisionale attenzionale e diventano parte dell'ambiente di decisione e influenza dell'organizzazione in una prospettiva di feedback. Ho poi indicato come e perché l'attenzione, legata ai sistemi di controllo, sia il motore trainante della creazione e dello sviluppo della conoscenza organizzativa, per dimostrare come lo sviluppo della conoscenza e dell'attenzione individuale potesse essere la premessa per un apprendimento organizzativo più completo. Più velocemente l'orga-

nizzazione impara a sviluppare attenzione e pensiero, più pronta l'intera organizzazione è in grado di affrontare le dinamiche esterne. Infine, sono andato oltre e ho riempito la letteratura recente sulla creazione di conoscenza e sulle routine, come sviluppo di teorie organizzative, dimostrando che ci sono evidenti prove che richiedono progressi nella cognizione, nell'attenzione, nell'apprendimento e nell'intelligenza; l'intelligenza si verifica quando la creazione di conoscenza organizzativa non finisce mai ed è, quindi, vista come un processo circolare non confinato all'organizzazione ma include molte interfacce con l'ambiente. Le organizzazioni sono, quindi, "depositi ideali" per "l'accumulo di conoscenza tacita", gran parte della quale è espressa dalle routine.

1 – Introduction

Since the 1980s, organizational theory has been explained from the perspective of open systems processes [Meo Colombo 2021, n.d.r]: that is to say, the organization has been seen as a processor of information into responses. The models presented in this work accept and embrace this organizational view since, thanks to control systems (Mella, 2012), the organization can deal efficiently with external stimuli and focus on strategy and goals. Control Systems are a fundamental part of the view of organizations as black boxes with feedback control, which process information, and they allow us to analyze the inner part of an organization, its behavior.

Thanks to previous analysis, we have discovered that organizations are not concerned only with processing external triggers but also with attentional processes which foster knowledge creation. We analyze the organization in terms of its structural capability to deal with environmental stimuli and behave according to attentional issue processing.

Knowledge creation is a process according to which external and internal information is absorbed, processed, and structured into models, and this contributes to creating organizational memory. Knowledge creation is a sense-making mechanism where decision-makers give meanings to triggers, define alternatives, and evaluate courses of action based upon their understandings (De Long and Fahey, 2000), which will be involved in organizational actions/moves. Therefore, to have a complete framework of analysis about organizations, it. is necessary to understand how knowledge translate into organizational moves, i. e., *routines*, and how the latter foster change.

We follow recent claims from a major part of the recent literature that ask for more detail about *"how routines are born?, how they relate to organization?"* (Parmigiani and Howard-Grenville, 2012, p. 447) and that view routines as dynamic systems in an attempt to understand their role in the organization (Pentland and Feldman, 2005). Control Systems help us to understand the inner part of organizations and to link attention to knowledge. Thanks to this achievement, we want to go further and understand how knowledge enters into routines to foster learning and change as a new approach to organizations, as shown in Figure 1.

Our aim is to fill a gap in the recent literature about knowledge creation and routines as a development of organizational theories, since there is a strong demand (Gavetti *et al.*, 2012) for progress in cognition, attention, learning, and adaptation.

We seek to improve the view of the static organization and move forward (Nonaka and Toyama, 2003), since we recognize that the organization develops and applies knowledge to solve problems, generating procedures and patterns of behavior according to control systems (Mella, 2012).

Thanks to this approach, new knowledge is generated that fosters organizational development since the

> organization is not merely an information-processing machine, but an entity that creates knowledge through action and interaction (Nonaka and Toyama, 2003, p. 3).
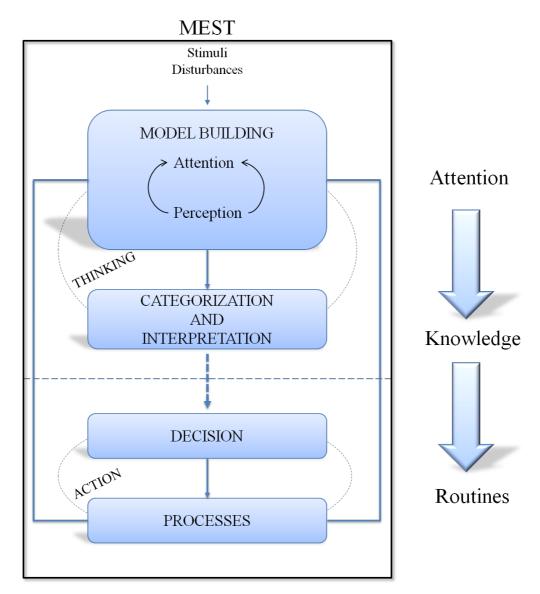
MEST

Figure 1 –The MEST as a generating structure for the coupling of Knowledge and Routines
(Author's elaboration)

Our assumption is that

> knowledge is not just a part of the reality. It is a reality filtered from a certain angle (Nonaka and Toyama, 2000, p. 4).

Knowledge, in effect, is reality filtered through the models that are constructed and connected by the cognitive system through his organs for the perception, attention, and arrangement of external stimuli. We argue that knowledge creation is a dialectic process involving attention and organizational structure (see Mella's MEST), and that this process may also be understood under Mella's control systems approach.

For a deeper analysis about the theory of knowledge conversion, from tacit to explicit, see (Nonaka, 1991, 1994; Nonaka and Takeuchi, 1995; Nonaka and Toyama, 2003). Focusing on knowledge as a means of linking attention to routines is

> a systematic and integrative process of coordinating organization in pursuit of major organizational goals (Rastogi, 2000, p. 40).

This concept, studied by management scholars (Davenport and Prusak, 1998), fits with our desire to join knowledge and routines to achieve learning and competitiveness. In particular,

organizations face crisis and contradictions, and the only way to overcome these problems is to "manipulate" knowledge to overcome obstacles and foster learning. The focus on the role of knowledge in fostering actions and learning seeks to fill in the missing pieces in the literature (Zheng, Yang and McLean, 2010).

Researchers have covered some ground regarding the contextual antecedents of knowledge (Choi and Lee, 2003). However, these studies do not focus on the mediating role of knowledge between attentional processes and organizational moves. For a deeper analysis of organizational culture, structure, and technology related to knowledge see Gold, Malhotra and Segars (2001) and Choi and Lee (2003). Our perspective highlights the importance of the links between attention, cognition/knowledge, and action as a means of achieving organizational competitiveness (cognition and knowledge are considered as parts of a unique: through cognition, knowledge generates). We also provide some insights, already analyzed in the past (Senge, 1990; Watkins and Marsick, 1996), on how organizational strategy can influence knowledge.

This work builds a more complex picture of how attention, control system behavior, knowledge, and routines are embedded together into organizations and foster organizational effectiveness. For further studies about knowledge measurement, see Choi and Lee (2003); and regarding knowledge and organizational effectiveness, see Davenport and Prusak (1998) and Shin (2004).

2 – Organizational Knowledge

[As I have previously noted,] in the early 1990s, some authors (Kilduff, 1993; Dodgson, 1993; von Krogh, Ross and Slocum, 1994; Weick and Westley, 1996) were concerned about the concept of "information" that had characterized organizational theories during the previous fifty years (e. g., March and Simon, 1958) and the tendency to cope *information* with *knowledge* (Newell and Simon, 1972).

Organizational knowledge creation theorists (Nonaka 1987, 1988, 1991, 1994; Nonaka and Takeuchi, 1995; Argote, McEviliy and Reagans 2003) saw the need to shed light on knowledge as a means of helping organizational creativity, innovation, change, and learning.

> It is widely observed that the society we live in has been gradually turning into a 'knowledge society' (Drucker, 1968; Bell, 1973; Toffler, 1990). The ever increasing importance of knowledge in contemporary society calls for a shift in our thinking concerning innovation in large business organizations be it technical innovation, product innovation, or strategic or organizational innovation. It raises questions about how organizations process knowledge and, more importantly, how they create new knowledge (Nonaka, 1994, p. 14).

We focus on "attention allocation" and "information processing" as a predominant theme in "attention-based theories" of the firm (Simon, 1972, 1979; Ocasio, 1995, 1997, 2011; Ocasio and Joseph, 2005), linking this with information and knowledge creation (Nonaka 1987, 1991, 1994; Nonaka and Takeuchi, 1995, 1996;) since every organization faces changing environments. As we have seen, these theories imply that decision makers' *attention* is a precious resource to deal with, and it is fundamental to select the activities to allocate attention to in order to develop environmental triggers in organizational moves. Thanks to individual cognitive frameworks, decision makers create and process information according to their "pool of attention" (Tseng, Fang and Chiu, 2011, p. 52).

Knowledge creation is a process by which individuals, according to their cognitive repertoires, focus their attention on a set of issues and process information (i.e., knowledge acquisition) into decisions about levers of control and the goals to reach.

Viewing the organization as a recipient and processor of individual knowledge is consistent with Simon's thought since

> All learning takes place inside individual human heads; an organization learns in only two ways: (a) by the learning of its members, or (b) by ingesting new members who have knowledge the organization didn't previously have (Simon, 1991, p. 125).

Peter Senge completed this view by building his learning organization theory, arguing that individual learning inside organizations may be motivated by the organization structure itself, which creates routines to allow its members to learn together, following the "four disciplines" (Senge, 1990). In fact, routines stem from cognitive mechanisms and are a basis for maintaining the internal coherence of the organization (Fransman, 1994).

Knowledge creation depends on the individuals' attention and their ability and attitude to process issues into strategies and policies. Therefore, we view the organization as an apparatus which pushes individuals to activate and maintain attention processes and, according to control systems, generates behavior which develops and enriches organizational knowledge. In this sense, the organization can be seen as a "place", or a "space", where knowledge is generated and applied to develop organizational moves. In particular, we follow Spender (1996), Nonaka (1987, 1988, 1991), Nonaka and Takeuchi (1995, 1996), Nonaka, von Krogh and Voelpel (2006), who focus on knowledge generation and knowledge application within the organization. When individuals focus on some issues and build upon them and on organizational dynamics, they are crystallizing and connecting their knowledge into the organization.

Knowledge has assumed notable importance in management theories (Teece, 1981, 1982; Nelson and Winter, 1982; Teece, *et al.,* 1997), and it has been seen as a means, alternative to neoclassical economics, to solve unconventional behaviors of firms (Nonaka and von Krogh, 2009).

In fact:

> Knowledge is a multifaceted concept with multilayered meanings. The history of philosophy since the classical Greek period can be regarded as a never-ending search for the meaning of knowledge" (Nonaka, 1994, p. 15). Traditional epistemological concepts refer to knowledge as a 'justified true belief' (Nonaka, 1994, p. 14).

While established epistemology focuses on truthfulness as a knowledge attribute, we consider knowledge as a personal belief which, in turn, affects the creation of organizational knowledge (for future research, it could be useful to deepen the analysis regarding the traditional epistemological view of knowledge and that related to knowledge creation). The former emphasizes the static nature of knowledge, while our analysis, following Nonaka (1994), Nonaka and Senoo (1996), Nonaka and Takeuchi (1996), Nonaka and von Krogh (2009), sees knowledge as a dynamic human process involving the attentional processing of information according to personal beliefs, as part of an aspiration for the truth (Nonaka, 1994). Although "information" and "knowledge" are terms often used interchangeably, it is better to point out the distinction between the two. As notably argued Machlup (1983), information is a flow of messages or meanings which could create, re-organize, or modify knowledge. Dretske (1981) gives some useful definitions:

> Information is that commodity capable of yielding knowledge, and what information a signal carries is what we can learn from it (Dretske, 1981, p. 44).

> Knowledge is identified with information-produced (or sustained) belief, but the information a person receives is relative to what he or she already knows about the possibilities at the source (Dretske, 1981, p. 86).

Briefly, information is a set of messages, while knowledge is created and organized by the very flow of information, linked to the commitment and beliefs of its "holder" (Nonaka, 1994), who pays attention to certain issues and not to others. "*This understanding emphasizes an essential aspect of knowledge that relates to human action*" (Nonaka, 1994, p. 15). For a deeper analysis of the knowledge search as a problem-solving activity, see Nelson and Winter (1982); as a type of

organizational learning process, see Huber (1991 and O'Keeffe (2002); and as a means to learn and develop new skills and a way to adapt to environmental changes, see Cyert and March (1963). For further suggestions about the search for knowledge, see Tseng, Fang and Chiu (2011).

Organizational knowledge, which starts at the Level of Thinking in Mella's MEST (Mella, 2005a), is mediated by decision-makers' attempt to filter the thoughts and behavior of organizational members (Waterman, 1990).

> In an ambiguous and uncertain world, the most important part of decision-making is to digest the information from the environment to structure the unknown (Waterman, 1990, p. 41).

Therefore, global (organizational) knowledge relies on organizational attention processes, which are carried out by the firm itself and, therefore, by individuals inside the organization. The focus is on individuals as decision-makers since they embed the "mind" of the organization and their attention could ensure that organizational efforts are not dispersed across too many external and internal communication and search channels. In fact, according to Ocasio (1997), decision-makers need to concentrate their energy, effort, and mindfulness on a limited number of issues to achieve sustained strategic performance. Organizational knowledge is created when decision-makers pay attention to certain issues, codify them into categories (Weick, 1979; Dutton and Jackson, 1987; Daft and Weick, 1984), and behave according to control systems (Mella, 2012) to achieve set goals.

These concepts are not meant as a denial of the importance of the thoughts of individuals, or of their commitment and the interaction among all levels inside the organization, as expressly argued by Nonaka and Takeuchi (1995), but I believe the starting point for attention and knowledge creation is performed by decision-makers, at the Level of Thinking. Nonaka and Takeuchi (1995) conceive of knowledge as the "tip of the iceberg", i.e., composed of tacit and explicit dimensions.

> We can know more than we can tell (Polanyi, 1964).

Note: for more details about knowledge dimensions, see Nonaka and Takeuchi (1995, 1996), Nonaka, von Krogh and Voelpel (2006), Nonaka and von Krogh (2009), Polanyi (1966); regarding knowledge and mind links, see Bateson (1979); and for an analysis of the four modes of knowledge conversion, see Nonaka (1994, pp. 14-22) and Nonaka and Takeuchi (1995, pp. 220-225).

Therefore, it is possible to argue that an organization is not only a "machine" that processes information, but also a living organism that puts together data and information to fuel learning and innovation. In uncertainty contexts, managers need to be able – after having paid attention to events – to create cognitive frameworks that should be translated into a predominant collective framework – which we call procedures/routines – in order to act in ambiguous environments (Kaplan, 2011; D'Aveni and MacMillan, 1990).

After the "mind" of the organization sets up a path of organizational moves, it must be supported by collective knowledge development, as part of a feedback loop perspective.

In fact, Nonaka states:

> The prime movers in the process of organizational knowledge creation are the individual members of an organization. Individuals are continuously committed to recreating the world in accordance with their own perspective (Nonaka ,1994, p. 17).

> Knowledge is created by individuals. An organization cannot create knowledge without individuals. The organization supports creative individuals or provides a context for such individuals to create knowledge. Organizational knowledge creation, therefore, should be understood in terms of a process that "organizationally" amplifies the knowledge created by individuals, and crystallizes it as a part of the knowledge network of organization (Nonaka, 1994, p. 20).

"Organizational knowledge" is such only when individuals' tacit and explicit knowledge is shared among members, and this process can be called learning.

The opposite relationship is also true, whereby organizational knowledge is seen as influencing individuals' cognition, which, in turn, affects organizational knowledge in a continuous feedback relation.

This relationship can be interpreted as a spiral of organizational knowledge creation, when all four modes are "organizationally" managed to form a continual cycle. This cycle is shaped by a series of shifts between different modes of knowledge conversion, as shown in Figure 2.
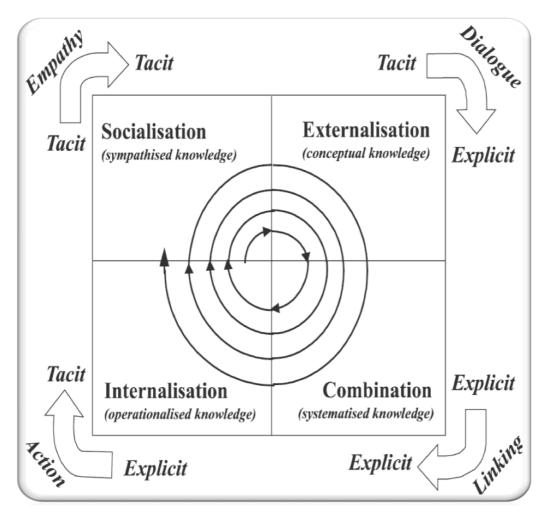

Figure 2 – Spiral of Organizational Knowledge creation
(Author's elaboration from Nonaka, 1994).

The spiral involves four different patterns of interaction between tacit and explicit knowledge. These patterns represent ways in which existing knowledge can be "converted" into new knowledge.

The significance of sharing is clearly stated by Nonaka, since:

> Social interaction between individuals provides an ontological dimension to the expansion of knowledge" (Nonaka, 1994, p. 19).

Figure 2 underlines four modes of knowledge creation through conversion:

1. from *tacit* knowledge to *tacit* knowledge. In fact, Nonaka notes:

> One important point to note here is that an individual can acquire tacit knowledge without language. Apprentices work with their mentors and learn craftsmanship not through language but by observation, imitation, and practice. The key to acquiring tacit knowledge

is experience. This process of creating tacit knowledge through shared experience will be called 'socialization' (Nonaka, 1994, pp. 19-20);

2. from *explicit* knowledge to *explicit* knowledge, a process which

involves the use of social processes to combine different bodies of explicit knowledge held by individuals. Individuals exchange and combine knowledge through such exchange mechanisms as meetings and telephone conversations. The reconfiguring of existing information through the sorting, adding, recategorizing, and recontextualizing of explicit knowledge can lead to new knowledge. This process of creating explicit knowledge from explicit knowledge is referred to as 'combination' (Nonaka, 1994, p. 20);

3. from *tacit* knowledge to *explicit* knowledge; and

4. from *explicit* knowledge to tacit *knowledge*, where

patterns of conversion involve both tacit and explicit knowledge. These conversion modes capture the idea that tacit and explicit knowledge are complementary and can expand over time through a process of mutual interaction. This interaction involves two different operations. One is the conversion of tacit knowledge into explicit knowledge, which will be called 'externalization'. The other is the conversion of explicit knowledge into tacit knowledge, which bears some similarity to the traditional notion of 'learning' and will be referred to here as 'internalization'" (Nonaka, 1994, p. 20).

From the above concepts, it is possible to view organizations as "intelligent cognitive systems" (as noted in Chapter 2) when they are able to develop models and set strategies and policies, thanks to the participation of all individuals in a spiral of knowledge creation approach.

Intelligence occurs when organizational knowledge creation never ends, and is thus viewed as a circular process not confined to the organization but one that includes many interfaces with the environment. For example, the relationship between knowledge creation and the environment could be found in reactions to products by customers, competitors, and suppliers. Many dimensions of customer needs take the form of tacit knowledge that an individual customer or other market participants cannot articulate by themselves (Nonaka, 1994).

In fact, following Nonaka,

the environment is a continual source of stimulation to knowledge creation within the organization" (Nonaka, 1994, p. 27).

According to our view of organization as a cognitive system which translates attended stimuli into knowledge and additional routines, an intelligent organization survives in a changing environment if it is able to learn.

3 – Knowledge, Control Systems, and Routines

There are different degrees of *managerial attention* which are transformed into knowledge (conversion or improvement of knowledge or existing knowledge) through the interaction of individuals, boards, and committees. Knowledge conversion is a process thanks to which diverse degrees of attention are combined and coordinated to get effective procedures (Ocasio, 1997). The works by Kogut and Zander (1992, 1993, 1996), Grant (1996) and Gavetti and Levinthal (2000) propose that firms are "ideal repositories" for tacit knowledge accumulation. Much of the latter "*is embodied by routines that typically are, at least, somewhat tacit*" (Parmigiani and Howard-Grenville, 2011, p. 420). As argued by Parmigiani and Howard-Grenville (2011), Zollo and Winter (2002), and Winter (2003) in relation to experience accumulation, knowledge articulation and knowledge codification provide the foundation for changes in routines. This means that knowledge creation and accumulation "comes before" routines. In fact, Helfat et al. (2007) also believes routines are connected to their resource base (i.e., knowledge), and

Parmigiani and Howard-Grenville state that "*routines embody knowledge*" (ivi, 2011, p. 420). The latter argue that routines are "*repetitive and recognizable patterns of interdependent actors*", and our work analyses their call to understand "*how these patterns are produced*" (*ivi*, 2011, p.421).

Knowledge creation theory explains not only the nature of knowledge assets but also the dynamic processes of knowledge creation in organizations (Nonaka, 1987; 1991; 1994; Nonaka, Von Krogh and Voelpel, 2006). The present article provides further development regarding questions like "*how routines are born and how do they die?*" (Parmigiani and Howard-Grenville, 2011, p.447) thanks to the link between knowledge and routines.

Considering its effects on action,

> knowledge is the capacity to act based on explicit and tacit elements, enhancing this capacity means making use of existing and new tacit and explicit knowledge (Nonaka and von Krogh, 2009, p. 638).

Therefore, routines come from knowledge since they are related to behavior.

Following Day (2005), some tacit knowledge must be the basis for explicit knowledge, and the process that converts tacit to explicit knowledge makes the latter independent ($\rightarrow$routine) and could be identified as a "process of knowledge externalization", which moves "along the continuum" (Nonaka, 1994), as showed in Figure 3:
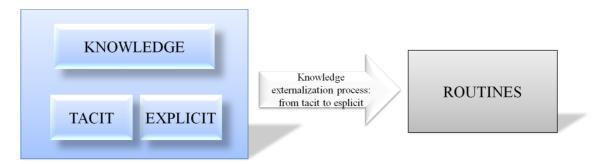

Figure 3 – Routines as the result of a process of knowledge externalization
(Author's elaboration)

Focusing on the "valuable" part of the continuum (Nonaka and von Krogh, 2009), we argue that "knowledge" embeds "routines" since it provides "procedures" (organizational actions that are visible). Confirmation regarding this issue could be found by analyzing the relationship between knowledge and routines in Nonaka and von Krogh's paper, since they argue that "*knowledge conversion becomes imperative for knowledge creation*" (i.e., procedures-routines-actions) (Nonaka and von Krogh, 2009, p. 636). Knowledge within a firm is embodied in operational routines and is modified by behavior (control systems) that set and achieve strategy and policy (Coriat and Dosi, 1995). In this sense, *we see organizations as behavioural entities that embody knowledge and shape it into routines*.

Knowledge is created thanks to attentional processes, as argued before, and to managerial behavior shaped by control systems, which influence future knowledge creation.

Recalling MEST, as a network of systems and subsystems whose behavior is shaped according to control systems, we argue that:

PROPOSITION 12: Organizational behavior is driven by a holonic network of control systems (Mella, 2005b, 2010) which operates ad different levels as an operative holarchy (Koestler, 1967) similar to Shimizu's Autonomic Cognitive Computer, thus generating Knowledge translated into routines.

> A holonic networks can be conceived of as a closed grid-like graph (with no beginning or end) whose nodes (vertices, points) are made up of same-level holons whose connections

(lines, edges, links, ties) represent the horizontal relations (before/after) among them (Mella, 2009, p. 73.

The concept of a Autonomic cognitive computer is described in Mella:

> Another interesting multi-level operational holarchy where a complex task is decomposed into partial tasks, which are then carried out by operative elements that make up a complete machine, is that described by Shimizu (1987) … Shimizu has theorized the construction of an Autonomic Cognitive Computer that can be conceived of as a holarchy of holons composed of modules that process information in parallel in order to carry out, through subsequent combinations, a complex operation that produces information at a final level of synthesis (Mella, 2009, p. 39).

PROPOSITION 13: Thanks to control systems, decision makers set decisions and operations/actions, influenced by cognitive and operative dimensions, to achieve organizational goals, maintain viability, and survive in changing environments (Mella, 1992, 2008). *Thanks to control systems, goals are posited, levers of control defined, and routines generated.*

The "mind" of the organization is involved in developing cognitive activities, creating individual and organizational knowledge frameworks and actions to take to achieve goals. In other words, the "mind" of the organization transforms knowledge into actions, defining goals, levers of control, and therefore effectors, detectors, and regulators (Mella, 2012).

Control systems are vital to knowledge development and actions to take to shorten the distance between planned and achieved objectives (Newman and Nollen, 1998). Control systems not only help managers shape their knowledge into levers of control and goals to posit, but also provide insights about where to focus future attention – and future knowledge creation – when an error is occurring. Control system errors allow decision-makers to understand where to focus attention to solve problems and maintain organizational fitness. It is evident how organizational behavior is shaped by Mella's control systems approach as a means to understanding not only when an error occurs but also "where" to focus attention to solve a problem, thus defining a learning path. In fact, according to Simon (1995) and Mella (2009, 2012), control systems are involved in generating *routines* and formal *procedures* based upon *information* and *attention*, which allow managers to maintain and/or modify organizational structure and behavior.

Individual knowledge creation comes from decision-makers' *attention*, which is translated into organizational moves according to the organization's needs. *Strategies* and *policies* are the result of decision-makers' attentional paths. The former defines control systems – which develop routines in reaching set goals – and analyzes possible occurring errors. These shift attention to re-define strategies and policies from a learning perspective. Routines embed organizational *knowledge* and *memory*, and their modification involves the organizational knowledge spiral, and therefore learning. Initial individual knowledge is then expanded thanks to all members sharing values, cognitions, and the organization's previous behavior.

We can describe this process as follows (Figure 4):

4 – Routines Foster Change?

The concept of organizational routines can be found in the Carnegie School (March and Simon, 1958; Cyert and March, 1963). Simon (1945), which introduced concepts about individuals as "boundedly rational" and organizations as rational systems, arguing that *routines* are essential in conserving time and attention when analyzing the environment and making decisions. Routines were, therefore, associated with a concept of *stability maintenance* and considered as simple *rules* or *patterns* of behavior that could facilitate decision-making and conflict resolution (Cyert and March, 1963; Cyert and James, 1992; Argote and Greve, 2007).

This paper explores the cognitive underpinnings of organizational behavior, embracing Nelson and Winter's work (1982), a notable example of routine explanation and analysis that went against traditional neoclassical economic assumptions (Mella and Pellicelli, 2008).

Defining routines as "*regular and predictable behavior patterns of firms*" (Nelson and Winter, 1982, p. 14), the authors provided an evolutionary change approach to organizations.
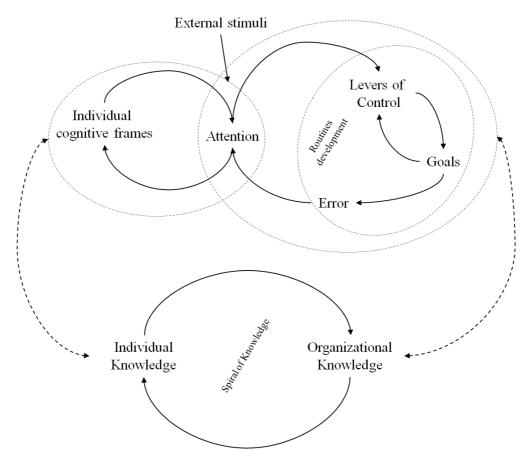

Figure 4 – Attention, Knowledge and Control Systems (Author's elaboration. Arrows stand for relationships, without consider their nature (i.e., positive or negative).

PROPOSITION 14: According to Mella's Control Systems approach, routines can be defined as a catalogue of *standardized control systems* or *decision systems* that are formalized to achieve recurrent goals or maintain stable well-defined variables in a set of environmental stimuli or disturbances.

In this sense, routines, like behaviors according to control systems, are related to "*know how to do*" (e. g., production) (Parmigiani and Howard-Grenville, 2011). Specific routines are preordained to direct *attention* to the occurrence of specific circumstances. Attention influences the understanding of routines as behavioral patterns of action developed according to a control system perspective. After routines are performed and errors (distances, differences, gaps, etc.) analyzed, decision-makers need to focus their *attention* on the achieved goals, and if errors are present, to decide how to intervene to reshape the control system.

In this sense, we can argue that:

PROPOSITION 15: Control systems help management understand were to *focus attention* and how to choose new *patterns of behavior*.

For example, on-off control systems represent simple organizational behavior which should not face problems, since the system stops when the goal is reached.

We must observe that control systems for dynamic objectives – or a plurality of control systems that interfere with each other – may give rise to "complex" organizational behavior because the organization must continuously modify its "direction" to reach dynamic goals. "Complex" in this context refers to the necessity to develop a chain of control systems (and not only one) which allows decision makers to reduce the error (distance, difference, gap, etc.).

The power of control systems is that, although they are simple logical models of behavior, they are not only simple. Thanks to error diagnosis, decision-makers can use control systems – and therefore routines that come from control systems – as a means of defining a "*new combination of existing routines*" (Nelson and Winter, 1982, p. 130).

Control systems help managerial decision-makers not only understand what can be done at any time but also how it is possible to modify behavior and create innovation. We therefore argue that:

PROPOSITION 16: Although routines have always been considered as stable (Pentland and Rueter, 1994; Pentland, 1995), thanks to control systems they can be seen as a means for organizational change and to foster learning, i. e., knowing how and where "to go", since we do not live in an immutable environment. Control systems help management not only address *regular decisions* but also to *foster change*.

Our analysis fits appropriately into the schema of organization according to a cognitive approach [see Chapter 2], since control systems develop routines which are the result of a collective mind (Parmigiani and Howard-Grenville, 2011) and efficiently drive collective action.

Therefore, our work entails the cognitive realism approach developed by several scholars from various perspectives (Cohen et al., 1996) who have focused on routines as repeatable and selectable patterns of action which involves

> executable capability for repeated performance in some context that has been learned by an organization in response to selective pressures (Cohen et al., 1996, p. 683).

Some scholars have studied routines as behavioral regularities managed by specific control systems and conducted mindlessly unless disturbance by external stimuli or crises produce the unavoidable attention to activate control levers or to innovate, thereby generating other routines and controls (Gersick and Hackman, 1990; Louis and Sutton, 1991).

In this sense, Louis and Sutton (1991) highlight the importance of the context since they analysed "*carefully designed artefactual environments within which workers can learn coordinated behaviours*" and confirmed that routines are made up not only of automatic actions but also of tacit elements involved in problem-solving activities (Parmigiani and Howard-Granville, 2011). Cohen et al. (1996).

The "practice perspective" analyses the process inside the "black box", which represents *routines*. Therefore, they are studied as day-to-day activities and their consequences are examined. Empirical studies on practice perspective can be found in Feldman (2000, 2003), D'Adderio (2003), Howard-Grenville (2005), Lazaric and Denis (2005), Reynaud (2005), Hales and Tidd (2009) and Zbaracki and Bergen (2010), in terms of a longitudinal study.

From the *practice perspective*, routines are considered as "*repetitive, recognizable patterns of interdependent action, carried out by multiple actors*" (Feldman and Pentland, 2008, p. 95) and as "everyday activities of organizing" (Feldman and Orliowsky, 2011, p. 1).

Dosi, Nelson and Winter (2000) looked at routines as repetitive activities that, together with other activities, define organizational capabilities defined as the replicable capacity to sort out defined actions. The capability perspective views routines as "black boxes" that accomplish organizational goals. From this perspective, routines are defined as

the building blocks of capabilities, with a repetitive and context-dependent nature" (Dosi, Faillo and Marengo, 2008, p. 1167),

and could foster not only stability but also change.

Note: Empirical studies on the capability perspective can be found in Adler, Goldaftas and Levine (1999), which analyses the link between flexibility and efficiency; see also Karim and Mitchell (2000), Knott (2001, 2003); regarding routines and performance in strategic alliances, see Zollo, Reuer and Singh (2002); on pricing processes as capabilities, see Dutta, Zbaracki and Bergen (2003). Mitchell and Shaver (2003) deepen the concept of integration capability to achieve a target, Gilbert (2005) analyses routine inertia, Peng, Schroeder and Shah (2008) study operations capability linked to routines, and Aime, et al. (2010) routines and employee mobility.

As seen above, routines are usually viewed as expected operations (Parmigiani and Howard-Grenville, 2011; Abell, Felin and Foss, 2008; Gavetti, 2005; Teece, 2007), but they can also be influenced by *attentional processes* developed by decision-makers during control system error analysis, and therefore foster learning.

Routines are a sticky concept to analyze and understand, but thanks to the control systems perspective we can argue that:

PROPOSITION 17: Control systems are modes of structuring typical and regular operations (routines) and therefore promote stability and consistency. We define them as ordinary control systems.

Routines, defined and shaped by control systems, are *repositories of organizational knowledge and memory*, both *explicit* and *tacit*,

much of which is embodied by routines that are typically at least tacit" (Parmigiani and Howard-Grenville, 2011, p. 420).

Early studies considered organizational learning as a "routine-based approach" (Dodgson, 1993; Darr, Argote and Epple, 1995; Argote and Darr, 2000) and as being "built on organizational routines" (Levitt and March, 1988, p. 320). We therefore embrace some authors ideas (Kogut and Zander, 1992, 1993, 1996; Grant, 1996; Gavetti and Levinthal, 2000) about organizations as ideal repositories for tacit knowledge accumulation (some insights about knowledge and routine can also be found in Nelson and Winter, 1982; Polanyi, 1967).

Observations of routines reveal they change continuously, leading authors to analyze their role in flexibility and change (Pentland and Rueter, 1994; Adler et al., 1999; Feldman, 2000). Empirical findings have caused theorists to argue that organizational routines are dynamic systems and not static objects (Cohen at al., 1996; Lazaric and Dennis, 2005; Hodgson, 2008; Feldman and Pentland, 2008). We could therefore expand the concept of organizational routines by arguing that routines rely on the capacity of the organization to *identify*, *assimilate*, *store*, and *understand* internal and external knowledge. Some useful insights for studying this topic can be found, for example, in Abell, Felin and Foss (2008) and Lewin, Massini, Peeters (2011). To understand how the organization creates, expands, and modifies its knowledge base thanks to routines, see Helfat et al. (2007).

Both perspectives on routines – practice and capability – provide insights on the *key mechanisms* by which routines are linked to exploration and exploitation (Lavie, Stettner and Tushman, 2010; March, 1991; Parmigiani and Riviera-Santos, 2011, Quinn and Paquette, 1990). Furthermore, the practice perspective suggests considering routines as *Janus-faced*, since they are *stable* and *dynamic* (evolve). Further, Feldman (2000) and Zbaracki and Bergen (2010) argue that routines can lead to change.

PROPOSITION 18: Control systems are means of producing creation and change (Helfat et al., 2007; Winter, 2003); in this sense, they produce the "chain" [error analysis → attention →

definition of new behavioral patterns]. *We define them* as generative control systems, *since they foster not only adaptation but also support learning.*

Works by Karim and Mitchell (2000), Zollo, Reuer and Singh (2002), and Mitchell and Shaver (2003) view routines as a basis for learning and show

> how routines can influence firm boundary decisions (Parmigiani and Howard-Grenville, 2011).

Although, as previously mentioned, routines are usually associated with stability, they become a source of *organizational learning* when *attention* translates into knowledge, which, in turn, shapes routines according to a control systems perspective aimed at erasing occurring errors. Therefore, control systems can be actively "used" to shape routines and promote organizational learning. They help organizations understand weaknesses and point out levers of control and objectives that can make them competitive and viable over time. Control systems thus become a "unit of analysis" and have a fundamental organizational role that underpins not only stability but also flexibility and learning.

In effect, control systems help management understand the future and the probable outcomes obtained from planned behavior, in an attempt at spanning organizational boundaries.

5. – Change in organizations. The wheel of culture

Not only do the cultural bases of individuals and the cultures of the organizations change, but the organizations also evolve by modifying their structures, processes, and output in an attempt to loosen the old restraints while setting new objectives and rewriting the programs for their achievement. Thus, to complete our framework, and following Mella and Meo Colombo (2012), to survive in a dynamic and changing world, organizations must react by adapting or innovating not only their own structures and behavior – as noted above – but also, and above all, their own cultures (Meo Colombo, 2012). Organizations must activate and implement a timely "change management process" conceived of as:

> The systematic approach and application of knowledge, tools and resources to deal with change. Change management means defining and adopting corporate strategies, structures, procedures, and technologies to deal with changes in external conditions and the business environment (Mella and Meo Colombo, 2012, p. 1).

This process must become "physiological" for individuals (Lewin, 1951), social groups, or organizations (Senge, 1990), and it represents the natural approach for dealing with change both at the individual and organizational levels for all types of organizations (Hiatt, 2006).

The survival of an organization as a cognitive system depends on its ability to understand and dominate the changes in the variables that influence the choices of individuals, groups, and organizations. Therefore, it is interesting and useful to recall the *model of change* developed by Mella and Meo Colombo (2012), according to which organizations, made up of individuals, can adapt to environmental dynamics.

The model considers change management as a system that acts on three important *wheels of change* that are powered by cognitive and cultural *motor wheels of change*. This approach reflects a metaphoric view according to which organizational and cultural change are clearly described. In fact, in the face of environmental pressures, the capacity of a social cognitive system to survive at length depends on the development of "teleonomy", based on Jacques Monod's (1970) conception. Winning the challenge of complexity depends on the ability of the change managers to understand *when*, *where*, *why*, and *how* control system errors occur and to regenerate the internal vital processes by undertaking a lasting autopoietic behavior aimed at maintaining the organization through the continual reproduction of the vital processes.

Change management is not a simple process but involves several fundamental phases:

1. ascertaining errors and which level of the organization is dissatisfied with the present situation and the need for change;

2. recognizing the optimal situation to achieve;

3. identifying the paths of change;

4. structuring a strategy of change;

5. directing the actions of change;

6. controlling the adequacy of the changes effected to achieve the desired optimal situation.

These phases, according to Mella and Meo Colombo (2012), lead to recognizing that *change management* is a process of *problem-finding* and *problem-solving* (Nickols, 2010, 2011); that is, a general control process of systems to move them toward the objectives that allow them to survive. Mella and Meo Colombo's model (2012) of effective organizational change underlines the need for:

a. change in the internal operational *programs*, understood also as norms, regulations, instructions, etc.;

b. change in the *structures*; that is, in the organization of the organs and individuals;

c. change in the *culture*; that is, in the cognitive and behavioral models of the individuals or groups that participate in the organizational structure.

The three paths of change are interconnected, like wheels which lead to change at different speeds (Mella and Meo Colombo, 2012), generating an inexorable process of change as shown in Figure 5:
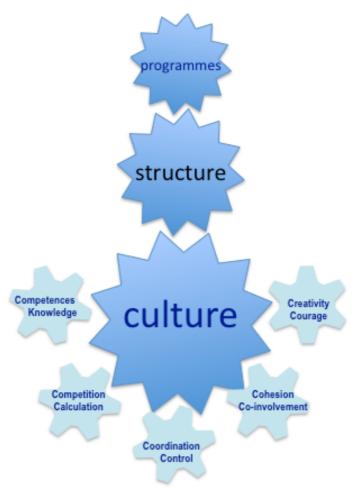

Figure 5 – Wheels of Change in organizations (source: **Mella and Meo Colombo, 2012**)

The five "motor wheels" of cultural change mentioned in Figure 5 – the little wheels which move the great wheel of culture change – do not necessarily operate simultaneously. Change can arise from any of them, but under the condition that the other wheels do not produce so much resistance that the effects are neutralized (Zucker, 1977). If there is no resistance to the movement of even a single "motor wheel", then when the large wheel of culture starts to slowly rotate in the direction of improvement, even the other wheels of change will be spurred on to produce positive effects.

According to Mella and Meo Colombo (2012), who adopt a top-down view, the small wheel of programs is the fastest. The change in the programs that regulate the processes is the fastest but also the least effective: "it spins easily and quickly".

> Nothing is easier than changing a norm, a regulation, placing a ban, and limiting the alternatives. Any programme change can be modified by a subsequent change. The speed of the small wheel's rotation assures a timely adjustment to environmental dynamics (Mella and Meo Colombo, 2012, p. 8).

However, the small wheel causes the medium wheel to spin, even though slowly. The change of an operational *program* imposes a change in the *processes* performed, which is often traumatic for the structure, which is thus forced to adapt slowly to respect the modified programs. The structure learns the new changes and itself changes. In this sense, routines developed in planned activities can be seen as sticky procedures.

To change *cultural models*, which constitute the individual and collective identity (Kluckhohn and Kroeber, 1978), it is essential to adjust cognitive frameworks through a complex process, described as follows:

a. above all, it is necessary to recognize the cognitive and value models still existing and the ones developed after attentional processes, in order to deal with change.

b. secondly, the organization, after having analyzed the errors that have occurred, should "adapt" such models in view of complexity, i.e., replace them by others;

c. the new cognitive models, in turn, affect organizational moves, and therefore organizational knowledge creation and sharing.

d. the creation of a dynamic basis of attention and knowledge creation, thanks to control systems and routines, positively influence a successful change management program.

Our control system approach to attention, knowledge, and routines describes how an organization should behave in a dynamic world with a lot of competition, becoming a dynamic organization trying to become a learning organization. The processes described above should give rise to creativity and to the desire to evolve, breaking away from uncritically-accepted schema.

According to the framework of analysis provided in this work, "reactive" thinking, which looks to the past and leads to eliminating errors and avoiding failures, must be replaced by "proactive" thinking, which is typically forward-looking and leads to planning actions, setting objectives for success. *Unpredictability* must become a factor in success and *creativity* should not only involve imagination but also translate into organized and social action; for this reason it is necessary to join to this new cognitive attitude the required *courage* to escape from long-held patterns of behavior and risk innovative behavior.

6 – Conclusions

Organizations are seen not only as "simple social systems" that produce and process information for action but as "living entities" that generate *knowledge* and *routines* through *attention*, *action,* and *interaction*. Moreover, organizations are conceived of as "intelligent

cognitive systems" that can develop models and set strategies and policies thanks to the attendance of all individuals, following a spiral knowledge creation approach. This means that intelligence occurs when organizational knowledge creation is interpreted as a circular process that is not confined to the organization but includes many interfaces with the environment.

This paper has developed a framework which shows how knowledge creation and accumulation "comes before" routines, also demonstrating the role of Control Systems in helping managerial decision-making understand not only what can be done at any time but also how to modify behavior and create innovation. Although routines are usually associated with stability, our framework provides new insight into organizational theories, showing that the *routines* become a source of *organizational learning* when *attention* translates external stimuli into *knowledge*, which, in turn, identities *routines* according to a control systems perspective aimed at eliminating errors. This new approach helps us understand how knowledge generates, improves, and fosters organizational development. In fact, organizations are conceived of not merely as information-processing machines but as *cognitive entities* that create knowledge through action and interaction.

The present work highlights the importance of the links between attention, cognition/knowledge, and action and demonstrates how organizations, by focusing on knowledge as a way of linking attention to routines, develop a systematic and integrative process of coordination in pursuit of major organizational goals, thereby achieving competitiveness.

Since organizations face crises and contradictions, the only way to overcome these problems is by "manipulating" knowledge to overcome obstacles and foster learning. Focusing on the mediating role of knowledge between attentional processes and organizational moves, this paper contributes to filling in the missing pieces in the literature. Thus, control systems are presented as a means of developing routines and promoting organizational learning, which could become a unit of analysis with significant organizational roles to underpin not only stability but also flexibility and learning.

Lastly, we have proposed a new model of *change management* developed by Mella and Meo Colombo, according to which organizations should understand the presence and the functioning of organizational "wheels" that activate change. The model presented, which views organizations as Control Systems, underlines the importance of the wheel of *cultural change* that is embedded in cognitive activities and behavior, as discussed above.

These achievements help us understand that a Learning Organization should be capable of systematic problem-solving and experimentation with novel approaches while learning from experience and benchmarking, transferring knowledge rapidly and efficiently to all parts of the organization as part of a sharing process.

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