Will The Real Complexity in Strategic Management Please Stand Up?

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EXECUTIVE SUMMARY

The terminology about organizational and environmental complexity has shifted from 'environmental turbulence' forty years ago, to 'chaos theory' and 'complexity theory' in recent times. But a clear exposition of the concept of complexity and its implications for strategic management remains partially elusive. This paper attempts to clarify the notion of complexity by analyzing and synthesizing various strands in the literature. A cognitive map of the concept is developed and then expanded into a conceptual framework that integrates several perspectives regarding complexity and its management. The conceptual framework is used as a basis to formulate the implications of the various types of complexity in strategy formation.

Keywords: Complexity, Strategy-Formation, Environment, Concept-Formation.

INTRODUCTION

Some of the dimensions of the concept of complexity in strategic management, in particular those related to environmental complexity, have been identified in early stages of the field. For instance, Emery & Trist developed a typology of environments, describing the concept of 'turbulent fields' in their paper on the 'causal texture of organizational environments' (Emery & Trist 1965). In strategic management, scholars have developed and made use of concepts related to environmental complexity (Ansoff & McDonnell 1990), such as the term "environmental turbulence', associated with unpredictability and pace of change.

Other approaches to environmental complexity take a different ontological approach to the environment, that of the social construction of reality. K. Weick has pioneered this approach with his concepts of enacted environment and sensemaking (Weick 1979; 1995; 2001), and other scholars have elaborated on the implications of Weick's concepts for strategic management (Smircich & Stubbart, 1985).

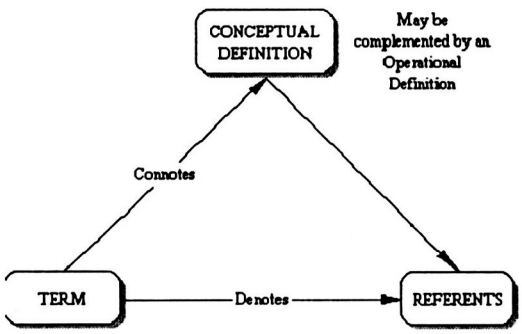
In more recent times, the concept of complexity has received renewed attention in the fields of Chaos Theory (Bechtold 1997) as well as in Complexity Theory (Anderson, 1999; Axelrod, 2001; Holland, 1998; Kauffman, 1996). In addition there have been other studies directly or indirectly related to the concept of complexity in general (Tsoukas & Hatch, 2001; Fioretti, 1996; Delorme, 1999)

The purpose of this paper is, primarily, to clarify and elaborate on the concept of complexity, and secondarily, to formulate the concept's implications for strategic management in general and strategy formation in particular. The paper is structured as follows. First we will present an initial approach to concept formation based on the methodology of the social sciences. Second, a sample of definitions and/or discussions of complexity in the literature will be given and briefly summarized, with the objective of identifying a broad range of meanings of complexity as well as its types. Third, a cluster of concepts related to the concept of complexity will be identified, building upon the range of meanings and types of complexity identified in the previous section. Fourth, a cognitive map of the concept of complexity is presented (which synthesizes and expands on the previous findings) and a conceptual framework is presented which includes central aspects of complexity as well as its possible management. Fifth and finally, the conceptual framework is used to formulate implications for strategy formation. The paper concludes with comments about the role of academia in the elucidation of the concept of complexity in the context of the practical concerns of practitioner-managers.

APPROACH USED FOR CONCEPT FORMATION

In this section, an initial approach towards concept-formation will be briefly presented. In general, from a semantic viewpoint, a concept has three main components: a term (a word), a definition (the verbal expression of cognitions about certain attributes of the referents) , and the referents or things (empirical objects) denoted by the term (Gerring 2001). These three components of the 'semantic triangle' or triangle of meaning are presented in Figure 1.

FIGURE 1: THE OGDEN-RICHARDS TRIANGLE OF MEANING



Notice that in the triangle of meaning, terms refer to things (referents), which are observable / empirical phenomena. This assumes an external objective reality independent of the observer. Furthermore, it also assumes that the conceptual definition is a verbal expression of cognitions / ideas as an abstract representation of certain features of reality (which could be potentially be measured in the things or empirical phenomena - referents, after an additional operational definition). Notice also that in the triangle of meaning the subject or observer using the conceptual term is implicit (the observer will be considered in later sections). In the following sections it will be seen that complexity is an elaborate concept associated to a cluster of related concepts that when linked could lay the foundations of a broader conceptual framework.

It could be useful to see how the use of the triangle of meaning is implicit in dictionary definitions. For instance, the first meaning of the term complexity given by the American Heritage Dictionary is: "consisting of interconnected or interwoven parts". Here the definition of the term complexity is referred to structural characteristics of objects, in this case, characteristics about the number of interconnected parts. To get a sense of the common sense of the term complexity, the dictionary adds a list of synonyms, including: complicated, intricate, tangled, and knotty.

In our case, the term complexity could possibly be given a definition encompassing a set of characteristics / attributes of the referents or observable empirical phenomena. For instance, the referents may be aspects of the organization and/or its environment, which when displaying certain characteristics (indicated in the definition) could be said to be complex. In the following section a sample of definitions obtained from the literature will be given.

SAMPLE OF DEFINITIONS

In this section we will present a sample of definitions and/or discussions related to complexity where the definition of the concept may be implicit. This is of course not a random sample but rather a theoretical sample in the sense used in grounded theory (Strauss & Corbin, 1997). Our objective is to identify a broad range of meanings associated with the concept of complexity. In a subsequent section we will expand and structure the range of meanings of complexity.

Our first definition of complexity will be the one given by Emery & Trist in their seminal article 'The causal texture of organizational environments' (Emery & Trist, 1965). In their article, the concept of complexity is discussed implicitly in the

context of environmental change, alluding to the observation that organizational environments are "changing at an increasing rate and towards increasing complexity," (p. 21), as a result, among other things, of the impact of technological change, the "increasing reliance on research & development, and the interdependence of economic forces with other aspects of society" (p. 25). They characterize two cases of environmental complexity. First, what they call "disturbed-reactive environment" which is characteristic of oligopolies and second "turbulent fields" which could also be called "turbulent environments." They state that these "turbulent fields" are in motion, to indicate the pace of change in these environments, as a result of technology and the pace of R&D, as stated before. And they are termed "turbulent" because of their complex "causal texture" which points to the complex causal dynamics of the environment's evolution.

From the viewpoint of organizations these changing "turbulent fields" represent a substantial increase in "relevant uncertainty". Emery & Trist point that interactions with these environments could have unpredictable consequences, beyond all expectations. To relate this definition to the 'triangle of meaning' discussed in the previous section we could identify the main elements. The term used is 'turbulent', the referent is a set of phenomena encompassed by the entities, forces, and events in the environment, and the definition that describes the properties of turbulence points to unpredictability manifested as uncertainty. Notice that this 'turbulence' or 'complexity" of the environment is in relation to a certain organization with a certain mission, current position and current strategy.

In the context of strategic management the concept of complexity is also addressed in the book entitled "Implanting Strategic Management" (Ansoff & McDonell, 1990). The concept of complexity is very germane to the intent of the book which is to present a "... systematic management of the adaptation by firms ... to discontinuous changes in the environment" (p. xv). Ansoff & McDonell point to the observation that during the twentieth century "environmental changes have become more complex and novel" (p. 9). They mention the 'frequency of changes" and also the 'rate of diffusion of change'. These, they say, lead to "an increasing difficulty in anticipating change sufficiently in advance" (p. 9) and "the need for increased implementation of the response (p. 9). They point to a highest level of 'environmental turbulence' where potentially disastrous environmental changes arrive suddenly, unanticipated, posing " ... novel problems in which the firm has little prior experience" (p. 21).

In response to the higher levels of "environmental complexity" they propose strategic management systems that match the complexity of the environments they face (an apllication of Roy Ashby's cybernetic law of requisite variety). In other words, as an adaptive response to increasingly high environmental challenges, they state "... it is necessary that management build progressively complex systems in order to deal with progressively more complex environments" (p. 24). In terms of the triangle of meaning their definition of complexity refers to environmental complexity and it is similar to that given by Emery & Trist and its ulterior variations. Again the term complexity is made in connection to the referent environment, and the definitional characteristics that make the environment complex include frequent, discontinued changes, which are either difficult to predict sufficiently in advance for an adequate response or are impossible to predict arising in a sudden and surpriseful way. While their definition is similar, they elaborate on the type of strategic management systems that are appropriate to respond to that type of environmental complexity.

So far, both the definitions associated with Emery & Trist's seminal article as well as the similar definition given by Ansoff & McDonnell, have assumed the existence of an organizational environment as an objective external independent reality. Other treatments of the concept of complexity take another approach which in the philosophy of the social sciences is termed the 'interpretive approach', associated with the idea of the 'social construction of reality'.

One of the pioneers of the interpretive approach in organization theory is Karl Weick who has also written, although indirectly and with a different terminology, about aspects of the notion of organizational complexity (Weick, 1979, 1995, 2001). For instance, Weick points to a kind of chaotic set of circumstances which is puzzling for the organizational actors involved, and which require on their part to tentatively interact with their circumstances while engaging in 'sensemaking' while at the same time 'enacting' a situation. In this process, which Weick calls 'organizing' the chaotic 'circumstances' are transformed eventually into a 'situation' which is more structured from a decision-making viewpoint. Notice that the change in this case arrives unexpectedly and the conceptualizing of the organized action and the relevant environment are made sense of and 'enacted' at the same time. We have here a state prior to the differentiation of the 'system-environmental ensemble', pointing to an even more primordial category of complexity than that covered by the concepts of either environmental and /or organizational complexity. Notice that here we also have an emphasis in the role of the social (organizational) actors who thorough their interaction and sensemaking activities 'socially construct' / 'enact' an organized

reality. In this case the triangle of meaning is inadequate since we no longer have an existing reality with independent referents, since the reality or situation is in the process of being socially created / enacted.

The concept of complexity is also treated in Chaos Theory (Kellert, 1993). Here one is dealing with nonlinear dynamic deterministic mathematical models of actual physical systems, consisting of a few differential equations. Although deterministic, due to their nonlinearity, these systems are highly sensitive to errors in the measurement of initial conditions. Small discrepancies will be magnified and will lead to significant differences in future system complexity. What is significant in these systems is that they are simple in their mathematical structure (just a few equations and thus no structural complexity) and yet due to their non-linear dynamics they lead to unpredictability of future behavior. Here we have a case of 'behavioral complexity' in closed systems with no structural complexity. Behavior is said to be complex because it is aperiodical (doesn't repeat itself) and unstable (marked differences in future states given extremely small differences in initial conditions). Nevertheless future behavior is not completely random but rather bounded in regions of state space called 'attractors'. In this case point predictions are not possible, but at least broad predictions are possible in terms of bounded regions of future state space, i.e., 'attractors'.

The field of Complexity Theory also deals, of course, with complexity [Axelrod, 2001; Anderson, 1998; Holland, 1998; Kauffman, 1996]. Here, the context is the study of 'complex adaptive systems' where overall system behavior 'emerges' from the local interaction of multiple system parts, interactions which are also nonlinear and filled with feedback loops. In these systems complexity refers to the number of parts or agents, and also to the number of interconnections among them. This is a case of 'structural complexity' and at the same time, due to the fact that these are 'dynamic systems" and that overall coordinated system-wide behavior, 'emerges' as 'time passes,' this is also a case of 'dynamic complexity'. There is no guarantee that 'emergent order' will arise. It all depends on the number of interconnections in the network of system nodes or agents, and on the rules that guide the individual behavior of agents. Complex adaptive systems are relatively closed, in the sense, that the simulation models in terms of which they are formulated include a closed 'system-environment ensemble,' where an organization represented by a network of agents interacts with other organizations with which it coevolves. Here we have a case of complexity brought about by both the structure and the internal dynamics of the system-environment ensemble.

Other treatments of complexity can be found in the literature. In contrast to the previous cases, where the intrinsic complexity of objects is emphasized (whether organizations or environments), there are approaches that highlight the role of the observer (which could be a scientist studying a system) or a participant-observer (interacting with a system). For example, Guido Fioretti argues that "complexity cannot be defined without previously modeling the individual's cognitive process" (p.1). He claims that "... complexity arises from the interaction between a system and its observer" (p. 3). He follows Rosen to state that " ... an observer sees a system as complex when he has more than one description of the system" (Rosen, 1985). He points that the individual observer "interacts with the social system undertaking actions and obtaining results" (p.7). He states that when the individual's mental model of the world (environment) fails in providing adequate orientation for the individual's interactions, because of the continual change in the environment, his mental model must change. Here we have a case of complexity as the degree of mismatch between the individual's mental models of the environment and environmental complexity. So, in this case when the mismatch is high and frequent (the individual's adjustments to his mental model are neither adequate not do they keep up with the pace of environmental change), the environment is said to be complex for that individual, Notice that we have here a hybrid case. On the one hand, we have 'environmental complexity' due to the 'turbulent causal texture" of the environment (environmental complexity) and at the same time 'observer-relative-complexity' due to the cognitive limitations and/or inquiry methods available to the observer. It is clear that in this case the triangle of meaning should be expanded to include the observer, or to be precise, the observer/actor interacting with the referents (elements in the environment).

The last study we will examine regarding complexity will be found in the field of organizational science (Tsoukas & Hatch, 2001). The approach is again similar to the last two, focusing on second-order complexity (complexity relative to an observer). Tsoukas and Hatch claim that the thinking of the scholar studying complexity is itself complex. Quoting Piaget they state "Intelligence organizes the world by organizing itself" (p. 980). They point that in order to properly describe and understand complex systems, traditional positivist research methods which rely on propositional statements for theory-specification (nomologico-deductive methodsand the associated hypothetico-deductive method of theory validation), are not adequate for several reasons. For instance they point that complex systems are nonlinear and sensitive to initial conditions while that is not the case with traditional propositional explanations. They also indicate that complex systems display paradoxical behavior while traditional theories do not allow for contradictions. And they also point out that complex systems

are causal and therefore allow for the use of time, while that is not the case in logico-scientific propositional theories. For these reasons they argue that the observer should use some kind of interpretive narrative to capture the nuances of the behavior displayed by complex systems. Similar to previous cases, Tsoukas & Hatch state that "complexity is in the eye of the beholder ..., a contingent property arising out of the interaction between a system and an observer / decision-maker" (p. 986). They also point out that "We interpret the non-linearity of complex systems as counterintuitive or surprising ... but the surprise rests on our perspective and in our violated expectations, not in the system" (p. 989).

A CLUSTER OF CONCEPTS RELATED TO COMPLEXITY

In this section we will reflect upon the types of complexity identified in the previous section in order to identify a cluster of concepts related to complexity. This is done to deepen our understanding of complexity as a network of related ideas / concepts, prior to attempting the development of a cognitive map that would capture the broad range of meanings of complexity.

Upon reflection on the sample of types of complexity identified in the previous section, we see that complexity is related to unexpected change. Change is related to time and leads us to inquire about the dynamics of the situation. Unexpected change raises the issue of surprise for particular participant-observers. Let us begin considering the concept of change. In our sample of definitions, change refers to either organizational and/or environmental dynamics. If we label the 'system-environment ensemble' as 'a situation', we could talk about 'changing or evolving situations'. Change of the situation could be intrinsic to the dynamics of the system (organization), and/or environment, and their interaction. But change could be also be surpriseful or unexpected relative to the cognitive limitation of the participant-observers and the adequacy of their models of the world and their methods for knowing the world. Thus, the concept of unexpected change implies a combination of intrinsic complexity and complexity relative to the observer.

We have seen that change is central to the understanding of complexity, and so we now turn to ponder about the sources of change. Regarding social systems, both organizations and their environments can be conceptualized as patterns of action, whether they be organizational patterns involving multiple actors in different roles, or environmental patterns of action involving multiple organizations in the task and contextual environments, as well as social groups (Weick, 1979). So we see that in social systems, changes are related to actions, or to be more specific, to patterns of meaningful interactions among the organizational actors and social groups involved in the 'system-environment ensemble' or 'situation'. Presumably, each of the actors in the 'situation' interact motivated partially by furthering their own interests, but their interactions may many times go beyond their intended expectations and bring about unintended consequences. This is so because there is both intrinsic complexity of the system-environment ensemble and also complexity relative to the cognitive capabilities of the actors themselves. The actors are no longer external to the overall situation but are part of the changing situation as well, which means that we now have a case of 'self-referential complexity'. In addition, we have also the problem of 'structuration' studied in sociology, where the individual actors are constrained to act and think in certain ways by the structure of which they are part of, while at the same time displaying a degree of freedom to either reproduce the existing social structures or attempt to modify them. (Giddens, 1986).

We have spoken about change as if it were easy to perceive and made sense of. Of course once an unexpected situation is upon an organization, with its associated negative consequences, organizations, and managers, specifically, are called to reflect about change and act upon it. This usually calls for a period of sensemaking that precedes strategic renewal based on a changed managerial culture more attuned to the new environmental realities (Lorsch, 1986). But we have seen that some organizations are more capable than others of perceiving and making sense of early signals of change, and thus are able to anticipate and react to change much earlier than others. These organizations have a capability that Weick calls 'mindfulness' (Weick, 2001), while the organizations blind to change display a mindless attachment to an habitual pattern of previously meaningful actions. We could say then that complexity relative to the participant-observer could be attenuated if organizations show the property of 'mindfulness,' resulting in an enhanced ability to perceive an make sense of change, with a faster rate of adjustment of their cognitive models of the world in relation to the pace of environmental change.

So far we have emphasized apparently objective and ready-made external environment to which organizations passively adapt, leading to externalist explanations of change (where the source of change is in the environment) and strategic renewal. But it can also be seen that organizations also create or enact new situations, through the power of strategic choice based on

the possibilities of action offered by the organization's capabilities. This is partly related to the economic and political power of organizations to shape their own situations. And the context here is the creation or construction of socio-technical-economic realities. Of course, given the complexity of the contextual environment, organizations will probably cluster to exercise this power, in the form of industry associations, etc. And we could see this phenomenon in the strategic alliances of organizations around supply chains and other inter-organizational arrangements. The ability to shape situations is an additional element of complexity that we have to grapple with, in the context of the possibility of partially managing the co-evolution of 'organization-environment ensembles'.

To summarize, we have identified a cluster of concepts associated with the idea of complexity: (a) intrinsic change in a situation, (b) unexpected change relative to a participant-observer, (c) change as a result of the unexpected consequences – at the situation level – of patterns of meaningful actors of the organizational actors, (d) mindfulness of early signals of change and the ability to make sense of changes as a basis for action, (e) ability to shape the situation through the power of strategic choice based on the organization's capabilities. In the following section we will attempt to develop a conceptual framework that could do capture many of the nuances of the concept of complexity we have identified so far.

TOWARDS A CONCEPTUAL FRAMEWORK OF COMPLEXITY & ITS MANAGEMENT

Given the multiple dimensions of the concept of complexity we will not attempt to provide a simple definition of complexity but rather develop a conceptual framework which will include not only a cluster of concepts related to complexity but also some preliminary concepts regarding the possibilities of managing complexity. However, prior to developing the framework, we will synthesize our previous findings in a cognitive map of the concept of complexity shown in Figure 2. For the sake of graphical simplicity, Figure 2 does not include the possibility of an organization partially shaping the situation through the power of strategic choice based on the organization's capabilities. Some of the elements of the cognitive map are used in the development of a conceptual framework, which is presented in Figure 3, discussed in the following section to formulate implications for the strategy-formation process.

FIGURE 2: A COGNITIVE MAP OF THE CONCEPT OF COMPLEXITY

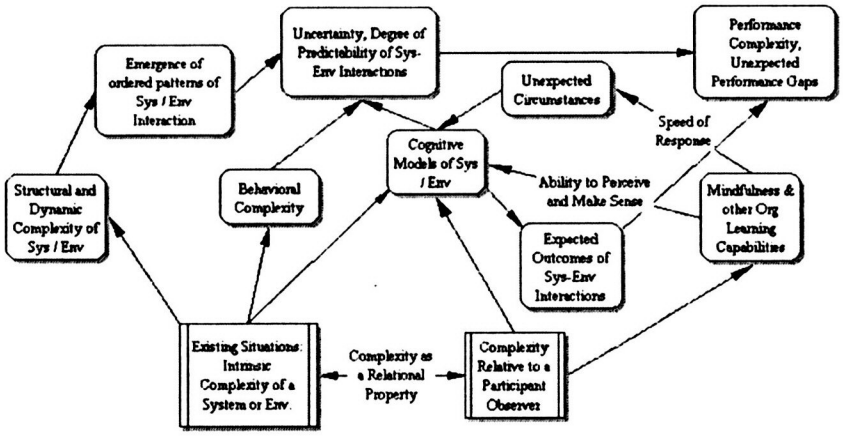
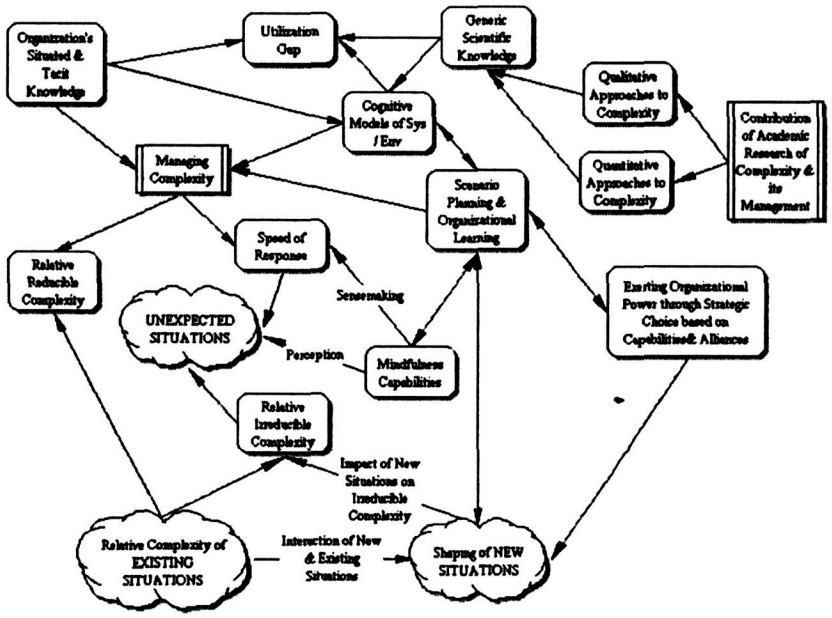


FIGURE 3: A CONCEPTUAL FRAMEWORK OF COMPLEXITY AND ITS MANAGEMENT



IMPLICATIONS OF THE CONCEPTUAL FRAMEWORK FOR THE STRATEGY FORMATION PROCESS

In this section we will attempt to elicit some of the implications of the concept of complexity for the strategy management process. This will be done partly on the basis of the conceptual framework presented in Figure 3, and also on background knowledge in the field of strategic management. In the figure, it can be seen that regardless of the power of an organization, and how well it manages complexity, there is a 'radically irreducible complexity' that will lead to 'unexpected situations'. To organize our comments about complexity and its management we will consider two types of strategies: as plans (intended) and as emergent (realized) patterns (Mintzberg & Waters, 1985). In both cases, we will try to indicate the impact of different types of complexity on their corresponding strategy-formation processes.

Regarding strategies as plans produced by a traditional planning process, the immediate implication of 'relative irreducible complexity' is the inability to predict the situation fully. This indicates that traditional planning has to be complemented by additional techniques such as scenario-planning. Since the new categories to perceive change will not be available, the capability of 'mindfulness' as presented by Weick will also be needed, leading to the complementation of traditional planning with techniques drawn from the field of organizational learning. This will lead to an improvement in updating the current cognitive models as an aid to managing complexity. Also, since tentative 'models of the world', some tentative probes of the environment will probably be made in conjunction with the use of scenario-planning and organizational learning techniques, which will be complemented with enhanced organizational 'mindfulness (van der Heijden, 2002). Thus, the traditional planning process becomes no longer a merely cognitive process where thought fully precedes action. That is still partly the case, but now there is also a concern for using other techniques such as scenario-planning, organizational learning, and enhanced 'organizational mindfulness,' to enhance the adequacy of cognitive models of the world as well as the speed of adjustment of such models.

For even higher levels of 'relative irreducible complexity', the focus will shift away from full-fledged intended strategies towards interactive organizational learning complemented by 'organizational mindfulness' and possibly some type of scenario-planning. This will require thinking in new terms, by drawing upon some of the conceptual imagery and metaphors available from chaos and complexity theory. Of course, powerful organizations will tend to manage complexity by exerting their power through strategic choice based on their capabilities and alliances, leading to vision–based and capability–based processes of strategy formation. In all cases, for both small and large organizations, management of complexity will require alignment with the emerging supply chain networks or configurations (partly shaped by the larger organizations). The focus of the strategy process shifts in the direction of the co-evolution not only of the organization-environment ensemble but also of interrelated groups of organizations.

As stated before, regardless of the power of an organization, and how well it manages complexity, there is a 'radically irreducible complexity' that will lead to 'unexpected situations'. This is where Weick's advice on 'organizational mindfulness' will help. Also, capabilities associated with learning and speed of response will be crucial. So here we enter the domain of agile adaptability and flexibility. This requires very open managerial and organizational cultures that are yet able to maintain stability and flexibility towards change at the same time. Here, concepts drawn form Weick's research on sensemaking and enactment would prove useful to help shape an appropriate strategy making process.

An additional implication concerns the role played by the knowledge produced by academic research in the management of complexity. We see in Figure 3, that the generic scientific knowledge produced by academia is an input to the cognitive models of the world in a particular firm. But we also see that there is a so called 'utilization gap' between the generic knowledge produced by academia and the kind of knowledge required by practioner-managers to manage their situated complexity. Here we notice that complexity means both current and future change and that firms have to commit resources in the face of future uncertainty. On the other hand, scientific knowledge is about regularities of relations among variables, oriented more towards the past. This points to the need to broaden the portfolio of research methods to go beyond 'propositional theories' or 'abstract causal linear models', which have significant limitations in aiding understanding of the dynamics of complexity [Tsoukas, 2001). Here, the practical need to expand the portfolio of research approaches could lead to the evaluation of complexity theory, as well as the possibility of using narrative / descriptive qualitative approaches (based on grounded theory) that could illuminate the subtle factors that lead to a dynamic understanding of complexity. But here we are on the verge of science as we understand it in a traditional positivist fashion. It is not only about pure explaining but becoming a participant-observer perhaps along the lines of an action-research approach. We begin entering the realm of interaction. Perhaps the consulting business has already partly anticipated this condition. But again, it could be hypothesized that 'radical irreducible complexity' may lead to a change in paradigm in the way management scholars engage in strategy-formation research. If not, the so called 'utilization gap' may widen.

In this paper we have developed a cognitive map of the concept of complexity as well as a conceptual framework about complexity and its possible management. We have also formulated some implications for the strategy-formation process both from the viewpoint of practitioner-managers and from the viewpoint of academia. In the process of this research, the original intention to give a simple definition of complexity, has given rise to two somehow intricate diagrams. Nevertheless, because of time constraints, our investigation of complexity is far from completed. We have highlighted cognitive aspects. But there are also other aspects related to implementation we have not addressed. We have also excluded innovation and its mechanisms as one of the major engines of renewal. And other issues like globalization, ecological changes, etc., have been excluded as well. We have also avoided reaching into issues related to post-modernism and critical theory, which add additional perspectives to appreciate the concept of complexity. Finally, we have dwelled in the dynamic or diachronic aspects of complexity, leaving aside the timeless or synchronic world of ideas, as well as their evolution and endless possible combinations, ideas that impinge on the minds of the actors participating in the historical process, influencing their thinking, as it were, from a fourth dimension. And there is much else that either we have not considered or is not yet known, or even beyond our capabilities of knowing. Complexity cuts across the fragmented knowledge of our multiple disciplines, scientific and otherwise, and overflows them. In this paper we have hopefully caught a glimpse, and only a glimpse of the world of 'real complexity', a world of which we are part and parcel, for better or for worse.

(The complete paper including references is available upon request)