Complexity in business environments

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ABSTRACT

This article analyzes the concept of complexity from an epistemological point of view, drawing a distinction between complexity (contextual complexity) and complication (procedural complexity). This article explores some organizational consequences of increasing complexity in organizational environments as management must cope with complexity at three different levels — internal, transactional environment, and contextual environment. The authors propose a model of managerial competencies in terms of complexity requirements and overview some consequences of this model for organizational learning and competence building processes.

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The complexity of organizations and its environments is a common subject in the management literature. For some 25 years at least, scholars have argued that organizational environments are becoming more complex (Emery and Trist, 1965; Schön, 1971). Sources of this increase in complexity include enhanced competition, deregulation (or more regulation), internationalization and accelerated technological change (Ohmae, 1990; Savage, 1990; Hamel & Prahalad 1994). Other authors analyze the managerial consequences of the rise of complexity (Handy, 1990; Quinn, 1992), and its learning requirements (Argyris and Schön, 1978; Ackoff, 1981; Ramirez, 1983; Morgan & Ramirez, 1984; Senge 1990). However, only a few management studies explicitly analyze the nature of complexity and its dynamics (Boulding, 1956; Simon 1962; Emery and Trist 1965; McCann and Selsky 1984).

The authors suggest that at least two fundamentally different meanings for complexity do exist, and that these two concepts have different consequences for organizational theory. The first part of this article examines how to define these two concepts of complexity. The second part develops an exploration of how complexity thus understood challenges management. The third part reviews consequences of these propositions for management theory and practice.

1. Closer look at complexity

Suppose you have a LEGO-style construction set, and that should complete two tasks:

- Build the tallest stable tower with the available blocks.
- Build the best toy for children with the available blocks.

Upon getting started, you will notice that these two exercises imply two completely different challenges. In order to build the tallest stable tower with the given blocks, one analyzes several tower designs and compares them with a fixed set of restrictions. The definition of this exercise is objective: Algorithms that exist are capable of discovering the best way to carry out the task. All relevant parameters are set and are not subject to discussion.

However, the second task involves a completely different challenge. To build a toy with the pieces of a construction set one may consider, among others, the following questions. (1) What is a toy? (2) What are the criteria for a good toy? (3) Which kind of toy to build? (4) How can I assemble a toy with the pieces I have? (5) Will the children like it? And are they the only stakeholders to consider — what about the parents? (6) Will the children recognize the toy as such? (7) Will they learn how to play with the toy?

Building a toy from a construction set is not only a matter of optimizing resources (blocks) for a given end. This activity is a matter of building the objectives based on incomplete or contradictory information and constructing a solution — not necessarily optimal — to attain these objectives. The key processes involved, in other words, are not just finding the best algorithms and of optimizing resources. Instead, establishing communication, interpreting desires, clarifying

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intent and building on ambiguity are the key elements involved. In this case the priorities among ends are neither well defined nor given in advance. When facing such problems managers create solutions because they must take into account elements that are not are not direct logical consequences of the problem. These elements emerge from the interaction between the problem and the actors who work on it, often changing the meaning of the terms used to describe it.

The two tasks are examples of two different kinds of complexity. Henri Atlan develops two complementary concepts of complexity (Atlan, 1979, 1991) which he respectively called algorithmic and natural complexity. In this paper the term complication refers to algorithmic (procedural) complexity; and complexity when refers to natural (contextual) complexity. In the LEGO construction set example, building the tallest stable tower is an example of a problem that addresses complication — algorithmic complexity. Building a good toy is an example of a problem that addresses complexity — natural, contextual complexity.

Algorithmic complexity concerns the difficulty to solve a given, well-defined problem. Solving these problems requires finding a solution through means stated in an algorithm (a predefined set of procedures that can be processed in a computer) and institutionalized as rules. A simpler problem would require a short algorithm and a more complicated one would require a longer one. Assembling a tower with LEGO bricks requires a relatively short algorithm. Sending men to other planets is a more complicated problem. Such problems require structuring calculations, selecting alternatives to attain a fixed, known end.

Natural or contextual complexity entails a different phenomenon. Natural complexity concerns situations in which finality is not a priori known — or knowable — by the actor in question. Here complexity is a measure of absent information. Complexity is a function of the degree of the actor's ignorance about the reality's working principles. When facing natural complexity both problems and solutions have to be factually (from factum, to make) invented rather than discovered out of data (from datum, givens). The LEGO example illustrates this kind of complexity.

Many ethical questions are examples of complex issues. They often demand more than calculation or structured quantitative procedures. They are hard questions, often addressed through contextual interpretation. One cannot apply structured methods to such problems, because actors do not completely understand the causal links between actions and results (actors know that elements are somehow related but they do not know exactly how they interact).

This study considers the complementary opposite of algorithmic complexity (complication) to be simplicity, and the complementary opposite of natural complexity (complexity) to be clarity. That is; simple problems are those that require little calculation, clear problems are those which can be unequivocally stated avoiding blur or fuzziness.

Table 1 shows that these two aspects (complexity and complication) are the basic dimensions of the complexity typology.

Some problems are at once simple and clear. These are trivial questions or non-problems. Filling a form with personal data or build a tower toy is an example of such problems. Other problems address either complication or complexity. Building a rocket, a nuclear power plant or improving a computer's processing speed is an example of

problems that address complication and allow formalized, structured problem-solving procedures. On the other hand, problems like building a good toy or performing a comic act (Eco, 1990) deal with primarily with (contextual) complexity. Simplifying these problems is not possible.

Some other problems are at once complicated and complex. For example: defining a country's policies is complex because this task requires interpretations about national fuzzy, difficult-to-define objectives (judgments about justice, equity, and values) and is also complicated because the task requires calculations, projections and measurements of many variables with different methods. These problems call for specific strategies to be dealt with.

2. Complexity and organization

Max Weber considers bureaucracy to be the ultimate stage of a rationalization process that embraced all aspects of modern societies (Weber 1919). He describes bureaucracies as hierarchical structures displaying strict definitions of each function's prescribed procedures as well as the required competencies and responsibilities associated with these.

In a bureaucratic organization, legitimacy derives from written norms in the form of conditional propositions (if X, then Y). Formal if–then rules define the organizational structure, the required competencies and responsibilities of each job, the recruitment procedures and the organizational borders. In a strictly bureaucratic perspective an organization is a set of interconnected norms. The bureaucratic ideal-type is a model of organization meant to best address complication as described above. The formal rules that define bureaucracy are collectively equivalent to a decision algorithm because they are sequentially applied in a structured decision making process to optimize known means to reach results which are a-priori set.

It's important to notice that Weber observed that no organization can be entirely bureaucratic. According to him, a bureaucratic organization should have at least a non-bureaucratic head. In fact, rule-based organizational designs, such as the bureaucratic model, imply a hierarchical allocation of functions to address organizational problems. Top management analyzes complex environments and sets strategic directions, while the lower levels apply the rules and formal procedures in executing their tasks. In terms of the theory of complexity here exposed, a bureaucratic organization thus concentrates complexity-driven decisions at the higher levels of its hierarchy and complication-driven decisions at the lower levels. The lower levels avoid complexity, which — if complexity were to enter these levels — would deter the efficient administration of complication. However, as organizations need to amplify their response potential, broaden the range of responses they do in fact act on, or enhance flexibility to address more complex or faster changing environments, they must develop approaches which break with this top-down complex-complicated division of labor.

Modern organizations have to deal with a broad range of problems that present different configurations of complication and complexity. Decisions that score low in both complication and complexity demand organizational routines like standardized forms, computer programs or fixed procedures. Problems that present high levels of complication, or procedural complexity, demand more elaborate procedures such as quantitative optimization methods involving operational research and data processing.

Problems include high levels of complexity, such as ethics and value orientations, demand contextual judgment often based on tacit knowledge (Nonaka and Takeuchi, 1995; Polanyi, 1967). Problems that exhibit at once high levels of complication and complexity, such as strategy making and applied R&D require at once appreciation, calculation, search and context building (Smith, 1983). As business environments become more complex, more critical decisions in organizations fall in this last category.

Table 1
Complexity and complication.

	Simpler	More complicated
Clearer	Build a tall tower with a construction set Fill a form	Build a rocket or nuclear powerplant Design faster computers
More complex	Design a good toy Being a good comic	Define a nation's policies dealing with justice, peace and economic growth

These different decision types also require different decision-maker abilities. Routines call for an efficient action oriented decision-maker. Routines are a means of storing organizational knowledge, embodied in the procedures and instructions. Routines are rule matching activities and the decision maker does no more than apply the pre-existing rules to actual cases. Efficiency regarding means is the key measure of a routine's performance. The best routines are the faster and more economical ones.

Value decisions require more wisdom and sense of community (Ramirez, 1999), than efficiency. They are the domain of learned, circumstanced choice based on soft, incomplete information (Checkland and Holwell, 1998). They rely on the ability to grasp and reinterpret bits of non-formalized knowledge. On the other hand, search and optimization problems demand a different decision perspective. They require at once factual knowledge, calculation, reckoning and modeling. Those activities go beyond a simple rule matching behavior and demand more initiative and imagination to reach the pre-defined goals. These correspond to research-oriented mindset and aim at building understanding as defined by Ackoff, that is: "explanations and answers to why questions" (Ackoff, 1996).

Finally, problems that are at once complicated and complex require both quantitative and qualitative skills. They require the ability to evaluate, estimate and make sense (Weick, 1995) of complex situations in order to set the strategic directions and to shape the problems to be solved, but they also require the ability to estimate and understand the outcomes and the forces that drive them. These problems differ from the value decisions because in the former the qualitative and quantitative dimensions are interlocked and isolating them is very difficult. Table 2 shows these four decision types.

3. Organizational forms and complexity

The basic characteristics of post-bureaucratic organizations are not consensual (Heckscher and Donnellon 1994). However, higher levels of environmental complexity impact modern organizations and make them fundamentally different from the traditional bureaucratic organizations (Heckscher, 1994). This article does not propose a complete description of such organizations but suggests that, in order to deal with high complexity environments, they should comply with three basic principles:

- Interactive, ongoing interpretation and enactment of its environments (Maturana and Varela, 1987)
- Co-defined boundaries
- Minimal critical specifications design (Herbst, 1974), aiming at resilience (Holling, 1976; Gunderson et al., 1995) and adaptability.

Daft and Weick (1984) suggest a model of organizations as interpretation systems. They argue that key managers in organizations make interpretations by selecting, out of an unstructured reality, some events they consider relevant and try to make sense of them. Daft and Weick propose a typology displaying four basic modes of organizational interpretation: (1) Undirected viewing, an opportunistic (and passive) process based on informal and non-routine data. (2) Conditioned viewing, a routine based passive detection process based on formal data. (3) Discovering, an active detection procedure based on formal search, questioning, surveys and data gathering. (4) Enacting, an active process of experimentation, testing and learning-by-doing.

Table 2
Complexity and complication in organizations: a decision typology.

	Low complexity	High complexity
High complication	Optimization models	Strategic decision making
Low complication	Routine operations	Traditional wisdom

High environmental complexity demands, other things being equal, that organizations adopt interpretation schemes based primarily on enactment. They thus act as strategic prospectors, guiding their decision-making processes through interactive learning. Pava studied and documented an example of this process among innovative city administrators in the US (Pava, 1980).

From an inter-organizational point of view, these processes open up the possibility that different organizations develop distinct interpretation schemes even if they operate in comparable environments. Moreover, if two or more organizations build effective collaborative arrangements, differences among them may imply a plus-sum result (Normann & Ramírez, 1993). Their interpretations of reality can be both compatible and complementary: they are directively correlated, as Sommerhoff suggested (Sommerhoff, 1969). They collaborate in an interactive process of co-interpretation of their transactional and contextual environments (Emery & Trist, 1965).

Boundary management is the process of defining (enacting) organizational borders, defining what is inside and what is outside the organization as well as what the organizations shares with others (Hirschhorn & Gilmore 1992).

Under high complexity conditions instead of building widely integrated and diversified production systems; organizations tend to form organizational matrixes (Emery & Trist, 1965; McCann & Selsky, 1984), networks of loosely coupled entities tied together by temporary relationships. Organizations facing high complexity environments would typically outsource non-core activities and concentrate their resources (material, financial and attention) on the most important activities. These organizations would also focus on boundary management to be able to gather a large number of actors (suppliers, wholesalers, retailers, government agencies, unions and even competitors) into collaborative relationships defining value co-production systems (Normann & Ramírez, 1993).

Co-production systems involve several actors, who jointly define their interactions and degree of overlap. As innovative co-production relationships are enacted, the roles of the economic actors change, thus redefining their boundaries. In this way organizations not only jointly and actively redefine their boundaries, but influence other actors to also modify their boundaries and inter relationships (Van der Heijden, 1993).

Organizations that work under high complexity conditions should not be over specified. They are meant to enable, not disallow, members to adjust to environmental changes. David Herbst proposed that organizations should follow minimal critical specifications (Herbst, 1974, 1976). He argued that adaptation, learning and creative and intelligent behavior require three basic factors:

- Internal variability to create alternative response patterns
- Testing of alternative response patterns and evaluation of the outcomes
- Selection of the most appropriate response.

Minimal critical specifications are the minimum set of conditions required to create self-maintaining and self-adjusting organizational units. Management should catalyze these processes and develop creative relations between the interdependent units. This development of relations contrasts with the internal control focus of bureaucracy.

This design principle aims at creating evolutionary systems, capable of adaptive behavior. He argued that reliable production does not require the complete specification of either production process or final product in advance. Managerial action cannot neatly distinguish specification of structure and structural implementation as two sequential and independent steps. The bureaucratic concern of eliminating variations, errors and discrepancies in advance appears as over-specification from this point of view. The variance kept within a given system improves its resilience (Holling, 1976).

Organizations designed according to the principle of minimal critical specifications alter the hierarchical allocation of complexity found in

bureaucracies. As stated before, bureaucracies tend to concentrate complexity at the top and complication at the bottom level.

Organizing through minimal critical specifications is a way of breaking with that division because ill-defined procedures and objectives allow the generation of opportunity-rich complexity, which Atlan defines as complexity through noise, and not only complication, at the lower levels of the organization as well as the higher ones.

Organizations act in two environmental levels: (1) the contextual environment, and (2) the transactional environment (Emery & Trist, 1965). The contextual environment is from the point of view of the organization, composed of the factors affecting the organization, but upon which the organization has no power or even influence. Economic conditions such as inflation, economic growth, exchange rates and interest rates or socio-political issues like international relations, law and demography are examples of factors that form the contextual environment. An organization can appreciate, track, understand and question its contextual environment (Smith, 1983). The transaction environment is composed of the organizations and individuals with which the organizations directly interact.

4. Complexity and management

The transactional environment is the set of elements with which the organization establishes direct contacts, such as suppliers and clients. Managers influence and design (or co-design) the relations they have with counterparts in this environment, aiming to jointly find the opportunities to invent new ways to create value.

According to this model, management copes with complexity at three different levels:

(1) The organization manages internal issues, coordinates, motivates, selects priorities, etc. These correspond to the classical, internally focused activities of management.
(2) The organization designs, influences, and constructs value co-production systems. Management here is done jointly with other organizations in order to create a constellation of actors that collaborate in the value creation process. The design of value co-production relationships implies managing continuous change to jointly seek improved resilience of the system.
(3) The organization appreciates, evaluates, questions and understands the general trends that compose the transactional environments. This contextual listening does not focus on consensus, but depends heavily on dialogue.

This article defines competence not only in terms of capacity of action but also in terms of learning abilities. In complex situations to build competencies is important to know what to do, why to do it, and not only to know how to do it. Three kinds of competences exist in this model:

- Managerial competencies. They include finance, accounting, marketing and personnel management technologies, procedures and routines used within the scope of a single organization.
- Networking competencies. Competencies related to the design of value creation systems. These competencies focus on building collaborative arrangements between economic actors to secure access to addressable resources (Wallin 1995). They include the capacity of attracting new actors to take part of a value system, the capacity of maintaining multilateral relations and the capacity of renewing those relations through innovation.
- Contextual listening competencies. These are competencies linked to the processes of appreciating, evaluating tracking and making sense of the potential changes in the organization's environment. These competencies include the identification of threats and opportunities, and developing alternative scenarios (Schwartz 1993, Van der Heijden, 1996).

To explore these three competence categories this article analyzes terms of complexity and complication. Considering complexity

and complication simultaneously leads to the definition of four types of decision complexity: (1) routines, (2) value oriented decisions, (3) optimization/search procedures and (4) strategic problem and opportunity setting. These four decisional complexity types directly relate to the knowledge decision-makers have about the organizational environments and fall into four categories.

- Explicit knowledge. Explicit knowledge operates in situations when decision makers know something and they know that they know it. Explicit knowledge is formalized, codified knowledge.
- Tacit knowledge. In this case people may know something but they may not know that they know something (Polanyi 1967, Nonaka and Takeuchi, 1995). This situation directly relates to the implicit, taken-for-granted assumptions about the world and the experiences accumulated by social actors, which they cannot render or exploit. Examples of decisions that rely on tacit knowledge are intuitions, perceptive insights, values and ethical decisions.
- Puzzles. In puzzle-type situations people do not know something but they know that they do not know it. They acknowledge that they ignore something but they can nevertheless frame the problem and they can direct their efforts to address it. These situations imply some knowledge on the subject: knowing one does not know something and knowing how to state the problem corresponds to some useful, important knowledge. Procedures engaged by scientists and engineers when trying to find a solution for a given problem exemplify it.
- Surprises. In this case people do not know something but they do not know that they do not know. Surprises are things or relationships not imagined to exist, which represent surprising discoveries.

To address surprises, decision makers must design learning strategies, ways of checking the official reality and dealing with unexpected crisis (Mitroff 1987, 1996). Table 3 summarizes these arguments.

5. Competencies and learning strategies

Organizations under high complexity conditions are more likely to face surprises (what they don't know that they don't know) and less likely to rely only on formalized explicit knowledge (what they know that they know). They develop new competencies to deal with increased complexity and complication. Refined routines, mature wisdom or sophisticated model building will not be enough. These organizations develop ways of learning with and co-create, the environment complexities, improving their resilience.

This section describes some methods organizations adopt to renew their competencies or to acquire new ones under high complexity circumstances. These methods receive the name: learning strategies (Michaels, 1973). The learning strategies implied here include the following:

(1) Controlling explicit knowledge: Explicit knowledge is a controllable and manageable and often tradable organizational asset. Explicit knowledge can also be stored in files and retrieved when needed. Documents, forms, computer programs or machine designs usually embody explicit knowledge. When managing explicit knowledge, managers should pay attention to the internal organizational issues but also to the transactional and contextual environments. The learning strategies they should develop are the following:

- Internal dynamics: Formalize planning and management processes. Write procedures. Clarify and refine financial, marketing and human resources routines.
- Transactional environment: Develop explicit co-production relationships and multi-lateral value creating systems. Setting up alliances, marketing channels and communication policies.
- Contextual environment: Tracking and analyzing environmental trends. Elucidating environmental dynamics and identifying possible discontinuities.

Table 3
Decision types.

Complexity and complication of the environment	Examples of decision maker profile	Type of knowledge addressed	Organizational responses
Low complication/ low complexity	Efficient operator • Building towers with LEGO bricks • Form filling	Explicit knowledge I know that I know	Design routines/structured decision making LOGIC
Low complication/ high complexity	Wise man, community integrator • Design good toys, • Comic performances • Address community values	Tacit knowledge I don't know that I know	Develop intuitions, perceptive insights, community and society fit FEELING and SENSING
High complication/ low complexity	Scientist/analyst • Building more efficient machines within pre-established parameters • Searching for the solution of pre-defined problems	Puzzles I know that I don't know	Structure search of solutions and optimization procedures. CREATIVITY AND INSIGHT
High complication/ high complexity	Strategist Defining policies (balancing contradictory factors and systemic dynamics) Interactively defining the problem and the solutions	Surprises I don't know that I don't know	Explore the environment; devise the future IMAGINATION/OVERCOMING CRISIS

(2) Governing tacit knowledge: Tacit knowledge is not a controllable and manageable organizational asset as explicit knowledge. Because tacit knowledge is not clearly defined or stated, tacit knowledge requires a different approach. Tacit knowledge government implies influencing, affecting and indirectly guiding the organization's collective values and beliefs. These governance issues evoke the management of human resources as a strategic asset (Pfeffer, 1998). Some learning strategies to address tacit knowledge include:

- Internal dynamics: Addressing informal organizational issues, studying organizational culture to avoid tunnel vision and least-common denominator behaviors. Searching for tacit blocks to change and trying to foster the development of potentially useful tacit knowledge.
- Transactional environment: Evaluating taken-for-granted assumptions, beliefs about the organization's objectives, competitive industry structure, competitive position, attractiveness, or established ways of doing business. Identifying and managing networks of people.
- Contextual environment: Evaluating of taken-for-granted worldviews and cultural patterns, allowing subordinates to question established truths, freeing time to think (like academic sabbaticals).

(3) Solving puzzles: When facing puzzle situations, organizations should focus efforts on clarifying objectives and constraints in order to facilitate the use of solution searching techniques. These are some of the learning strategies used here:

- Internal dynamics: Setting up research and development targeted innovation programs. Make extensive use of operations research and quantitative modeling.
- Transactional environment: Applying industry and competition analysis models. Developing integrated systems to optimize supply chains.
- Contextual environment: Building demographic, economic and environmental models.

(4) Devising and dealing with surprises. Dealing with surprises requires a mindset change in management processes (Mitroff, 1987).

Surprises do not entail the same management and governance procedures used to deal with explicit and tacit knowledge, but organizations should not be passive in a surprise prone environment. In this case, instead of focusing on knowledge managers should focus on absent knowledge (or ignorance). They should look for clues that indicate that possible surprises may arise. They should look for evidence pointing that they do not know something that may be relevant for their future. When dealing with surprises managers should focus on discovering — out of a taken for granted reality — the problems they might have to work with. They may be active in destroying the knowledge and the competencies they have if they find good reasons to do so.

Some learning strategies implied here are:

- Internal dynamics: Investigating the behavior patterns like those related to normal accidents (Perrow, 1984), events that are the logical consequences of a system's design principles. Also investigating the mechanisms behind and implications of accidental discoveries (e.g.: 3M's Post-it weak glue invention when looking for a strong glue). Such accidental discoveries can reveal the unsuspected characteristics of the organization and its interactions with the environment.
- Transactional environment: Challenging traditional value creation system designs by experimenting new collaborative arrangements (alliances, joint ventures, loose coupled networks, etc.). To do so one must develop enhanced dialogue capabilities aiming at understanding the other actors' needs, preferences and resources, possibly using what Pava called Normative Incrementalism, an interactive process of clarification of initially fuzzy objectives (Pava, 1980).
- Contextual environment: Radically questioning the contextual environment by actively searching for possible futures. Working with scenarios is a way to do this active search for the conceivable futures (Schwartz, 1993; Van der Heijden, 1996). This activity must go beyond the trivial, the likely outcomes of the present situation and must question the taken for granted assumptions.

Table 4 shows a summary of these learning strategies.

Table 4
Learning strategies under complexity.

	Management orientation	Learning strategies: internal dynamics	Learning strategies: transactional environment	Learning strategies: contextual environment
Explicit knowledge	Controlling	Formalize management processes.	Developing explicit cooperative relationships	Track and analyze contextual trends
Tacit knowledge	Governing	Understanding culture, searching blocks for change, managing people	Evaluating assumptions on industry structure	Evaluating of taken-for-granted worldviews and cultural patterns.
Puzzles	Solving	Targeted R&D, operations research	Building industry models	Building economic and environmental models
Surprises	Devising	Investigating "normal accidents" and accidental discoveries	Experimenting new co-production designs	Actively searching for possible futures

6. Conclusion and implications for Latin America

We suggest that complexity is not just a liability which bureaucratic forms of organization seek to minimize. Sometimes complexity can be enhanced, rather than decreased, to improve the opportunities for learning in a given organization or among a set of organizations. Complexity in this view is not a given characteristic of the organizational environments, but a manageable dimension of such environments. Increasing complexity can be a factor which contributes to organizational learning. Simplicity may enhance organizational effectiveness under stable conditions, but organizations looking for simplicity should not abandon efforts at better dealing with complexity. This article analysis suggests that simplicity and complexity can co-exist and co-evolve.

With the understanding of complexity sketched in this article, the role of organization design extends beyond the integration of diversity (Lawrence & Lorsch, 1967). Organization design entails the integration of incompatibility, of dissonance, and of contraries. The more business logics (Normann & Ramírez 1993) with different operational priorities can be held together within a single managerial structure, the better that structure will face complex conditions. This trend implies moving the focus of competence development away from the single organization, and away from formal systems, into areas that are less well known. Because of the close interlinking between organizations, organizations acquiring new competencies to address complexity will enhance the complexity of the transactional and the contextual environments for themselves as well as other organizations (Castels, 1996).

Organizations adapt to this greater complexity by perfecting their learning abilities, thus generating more complexity to other organizations. This vicious (or virtuous?) causal circularity implies that the job of managers is becoming both tougher and more vital. The reason is that the structured decision procedures, even in their most sophisticated forms, cannot replace the complexity of management contexts. In Latin America, as well as in other emerging economies, complexities are not only obstacles and difficulties, they can be the source of greater opportunities.

References

Ackoff R. The art and science of mess management. Interfaces 1981;11(1):20–6.
Ackoff R. On learning and the systems that facilitate it. Cent Qual Manag J 1996;5(2): 27–35.
Argyris C, Schön D. Organizational learning: a theory of action perspective. Reading, MA: Addison-Wesley; 1978.
Atlan H. Entre le cristal et la fumée. Paris: Editions du Seuil; 1979.
Atlan H. L'intuition du complexe et ses théorisations. In: Soulié FF, editor. Les théories de la complexité. Paris: Seuil; 1991.
Boulding. General system theory. Adm Sci Q 1956;2(3):197–208.
Castels M. The rise of the network society. Oxford: Blackwell; 1996.
Checkland P, Holwell S. Information, systems and information systems: making sense of the field. Chichester, New York: Wiley; 1998.
Daft R, Weick K. Toward a model of organizations as interpretation systems. Acad Manag Rev 1984;9:284–95.
Eco H. The limits of interpretation. Bloomington: Indiana University Press; 1990.
Emery FE, Trist EL. The causal texture of organizational environments. Hum Relat 1965;18:21–32.
Hamel G, Prahalad CK. Competing for the future. Boston MA: Harvard Business School Press; 1994.
Handy C. The age of unreason. Harvard Business School Press: Boston MA; 1990.
Heckscher C. Defining the post bureaucratic type. In: Heckscher C, Donnellon A, editors. The post bureaucratic organization. Thousand Oaks CA: Sage; 1994. p. 14–62.
Heckscher C, Donnellon A. The post bureaucratic organization — new perspectives on organizational change. Thousand Oaks: Sage Publications; 1994.
Herbst D. Socio technical design. Strategies in multi disciplinary research. London: Tavistock Publications; 1974.
Herbst D. Alternatives to hierarchies. In: Trist E, editor. The social engagement of social sciences, Vol 2. Philadelphia: University of Pennsylvania Press; 1976. p. 282–93.
Hirschhorn L, Gilmore T. The new boundaries of the boundaryless company. Harvard Bus Rev 1992:104–15 May-June 1992.
Holling CS. Resilience and stability of ecosystems. In: Jantsch E, Waddington C, editors. Evolution and consciousness. Reading (MA): Addison Wesley; 1976.
Gunderson L, Holling CS, Light S. Barriers and bridges to the renewal of ecosystems and institutions. New York: Columbia University Press; 1995.
Lawrence P, Lorsch J. Organization and environment. Boston: Harvard University Press; 1967.
Maturana H, Varela F. The three of knowledge. Boston: New Science Library; 1987.
McCann J, Selsky J. Hyperturbulence and the emergence of type 5 environments. Acad Manag Rev 1984 Jul 1984.
Michaels D. Learning to plan and planning to learn2nd ed. Alexandria VA: Miles River Press; 1973. 1997.
Mitroff I. Business not as usual. New York: Oxford University Press; 1987.
Mitroff I. The essential guide to managing corporate crisis. New York: Oxford University Press; 1996.
Morgan G, Ramirez R. Action learning a holographic metaphor for guiding social change. Hum Relat 1984;37:1-28.
Nonaka I, Takeuchi T. The knowledge creating company. New York: Oxford University Press; 1995.
Normann R, Ramírez R. From value chain to value constellation: designing interactive strategy. Harvard Bus Rev 1993:65–77 July–August 1993.
Ohmae K. The borderless world, Harper Business; 1990.
Pava, C. (1980). Towards a Concept of Normative Incrementalism, University of Pennsylvania, Unpublished Ph. D. Thesis.
Perrow C. Normal accidents. New York: Basic Books; 1984.
Pfeffer J. The human equation. Boston: Harvard Business School Press; 1998.
Polanyi M. The tacit dimension. London: Routledge & Keegan Paul; 1967.
Quinn JB. Intelligent enterprise. New York: The Free Press; 1992.
Ramirez R. Action learning: a strategic approach for organizations facing turbulent environments. Hum Relat 1983;36:210–5.
Ramirez R. Value co-production: intellectual origins and implications for management. Strateg Manag J 1999;20:49–65.
Savage C. 5th generation management. Bedford MA: Digital Press; 1990.
Schön D. Beyond the stable state. New York: Random House; 1971.
Schwartz P. The art of the long view. New York: DoubleDay; 1993.
Senge P. The fifth discipline. New York: DoubleDay/Currency; 1990.
Simon H. The architecture of complexity. Proceedings of the American Philosophical Association, vol. 106, 6; 1962. p. 467–82.
Sommerhoff G. The abstract characteristics of living systems. Systems Thinking. F. Emery. Middlesex, Penguin; 1969. p. 147–202.
Smith W. Organizing as power process, the creation of a conceptual framework and its application to the design of development projects. (Doctoral Dissertation). Philadelphia: University of Pennsylavania; 1983.
Van der Heijden. Concept research. Harvard Business Review (Sept–Oct); 1993.
Van der Heijden. The art of strategic conversation. New York: Wiley; 1996.
Wallin J. Customers as the originators of change in competence— building: a case study. 3rd International Workshop on Competence Based Competition, Ghent; 1995.
Weber M. In: Roth Guenther, Wittich Claus, editors. Economy and society, an outline of interpretive sociology. New York: Bedminster Press; 1919. 1968.
Weick K. Sensemaking in organizations. Thousand Oaks: Sage; 1995.