Chapter 7

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ARE FIRMS AUTOPOIETIC SYSTEMS?

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INTRODUCTION

More than 25 years since its introduction (Stengers, 1985; Varela, 1996), the paradigm of autopoiesis has been extensively disseminated in various scientific communities, with alternate fortunes and enthusiasm. Although many theorists treat it as a new paradigm shift in science, owing to its philosophical novelty, it is curious that the disciplines that were most reluctant to embrace such a new "Kuhnean revolution" were indeed biology, on which autopoiesis is founded, and philosophy, about which autopoiesis is supposed to have something radically new to say. The most promising developments in fact were attained in sociology (Luhmann, 1990; Ulrich & Probst, 1984), political science (Jessop, 1990, 1992), law (Teubner, 1988, 1993; Teubner & Febbrajo, 1992), ecology (Zeleny, 1995, 1996), and management (Kickert, 1993; von Krogh & Roos, 1996; von Krogh & Vicari, 1993; Morgan, 1986; Zeleny & Hufford, 1992; Vicari, 1991). This chapter focuses on the latter field. It is wondered whether firms are autopoietic systems—that is, whether the paradigm of autopoiesis is applicable to for-profit organizations. Although only applications to other sciences will be touched upon, it will be clear that results can be extended to all kinds of social systems. This argument can be summarized as follows:

> **Thesis I**: Autopoiesis is not applicable to profit organizations
> or, in other words, firms are not autopoietic systems.

However, many of the constitutive concepts of the autopoiesis paradigm, taken in a weak sense, may be useful to explain firms and social systems. These concepts are self-organization, self-reference, self-maintenance, autonomy,

identity, and recursive communication networks, for these are cybernetic concepts, which lie at the core of the autopoiesis paradigm. If appropriately reformulated they can be saved. Therefore, second-order cybernetics, by clarifying its basic concepts and epistemology, has much to gain from abandoning rather than espousing autopoiesis. This argument leads to the following:

> **Thesis II**: Autopoiesis does not coincide with second-order cybernetics, whose basic concepts, if not taken as on/off conditions, can be applied to social systems.

Rescuing cybernetics from autopoiesis makes it possible to renew the application of second order cybernetics to the social sciences. Through this "surgery" many philosophically naive concepts and some unacceptable managerial implications deriving from the autopoiesis paradigm can be avoided, thus overcoming resistances of philosophers and management scholars.

The next section will outline the basic concepts and main developments of autopoiesis, while the third section applies them to firms, developing fundamental aspects: invariance and change; closure and boundaries; system and environment; identity and membership; communication networks. Differences between autopoiesis and second-order cybernetics are highlighted, and a "degree approach" is developed as an alternative to the on/off approach. The fourth section outlines the demarcations between autopoiesis and second-order cybernetics, and calculates the gains of their separation. As the scope of the discussion is limited to operational concepts, methodological and epistemological questions are not dealt with.

BASIC CONCEPTS AND DEVELOPMENTS

Definitions

The concept of autopoiesis reached the international scientific community through an article published by Varela, Maturana, and Uribe in 1974 (Varela et al., 1974), sponsored by von Foerster (Varela, 1996). Its roots lie in cybernetics and in the neurophysiology of cognition, as developed at MIT by McCulloch and at the Biological Computer Laboratory (BCL) by von Foerster (Stengers, 1985). The autopoietic approach was subsequently refined and developed over a period of five years (Maturana, 1975, 1978; Maturana & Varela, 1980; Varela, 1979). Two readings edited by Zeleny (1980, 1981) established in quite a definite manner the essence of the autopoiesis paradigm, as well as differences between Maturana and Varela as to the possibility of its applications to the social sciences. Their last book (1987) marks the end of their collaboration and agreement.

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The main purpose of developing autopoiesis was to answer a classical question: what is life? In characterizing a living system, Maturana and Varela moved away from what was the emerging trend in molecular biology, which sought a solution in DNA and its programming code, as well as from population geneticists, who looked at evolution, with its properties of reproduction, adaptation, and selection. Yet, the stand taken by Maturana and Varela was far removed from the weak answers which were suggested by many biologists, in terms of a list of many features possessed to a varying extent by a system. Maturana and Varela were looking for a precise and definite answer, a property or a set of properties—all necessary and sufficient—which the system was supposed to have, and which were to define an on-off condition: living or nonliving system. On the first page of their seminal article (Varela et al., 1974) we find at once the global outline:

> We assert that reproduction and evolution are not constitutive features of the living organization and that the properties of a unity cannot be accounted for only through accounting for the properties of its components. In contrast, we claim that the living organization can only be characterized unambiguously by specifying the network of interaction of components which constitute a living system as a whole, that is, as a "unity." We also claim that all biological phenomenology, including reproduction and evolution, is secondary to the establishment of this unitary organization. (p. 187)

Hence *the essence of autopoiesis is neither reproduction nor evolution nor adaptation, but rather self-production of the invariant organization of a closed network*. That invariant organization represents and guarantees the identity of the system as a whole, as a unity.

> The autopoietic organization is defined as a unity by a network of productions of components which (i) participate recursively in the same network of productions of components which produced these components, and (ii) realize the network of productions as a unity in the space in which the components exist. (Varela et al., 1974, p. 188)

Invariance and Perturbations

The property of organizational invariance is essential as it addresses that of autonomy: being invariant, an autopoietic system does not adapt to the environment, at least unless nonadaptation to environmental features or changes menace its organizational invariance. Indeed, an autopoietic system filters, enacts, and reacts to the environment in order to maintain its autopoiesis (i.e., its self-production). That property is what was initially called organizational closure and subsequently operational closure (Varela, 1979). A system exchanges—is open to exchange—matter, energy, and information with the environment, but it neither receives inputs nor gives outputs. It only receives and gives perturbations, (i.e., a sort of "neutral inputs and outputs") which do not

affect system unity and organization. While traditional cybernetic meanings of inputs and outputs refer to some sort of possible orientation or control or governance of the system, an autopoietic system is autonomous and maintains its own identity. Autopoietic systems do suffer only from environmental perturbations, which are defined as incapable of modifying the system's organization. They are supposed to leave unchanged the relational network between system elements. It is implicitly assumed that perturbations can affect the system's organization only if the system is not autopoietic, or in case it dies and transforms into another auto- or allopoietic system.

Operational closure

Operational closure is a fundamental concept, which should be analyzed using the notions of operations and closure. The former refers to component actions, which are determined by component role and nature, and by their reciprocal interconnections. Operations are all self-contained, which explains autonomy and self-reference. What can be exchanged with the environment is only energy, matter, and information, provided that the latter is not in the form of components. Closure refers to the relationship between system and environment. Any environmental change is selected (perceived, enacted) by the system, in order to maintain its organization (i.e., its autonomy [identity]). A system can give rise to structural changes as needed to adapt to environmental changes, always maintaining (preserving) the existing organization (identity). If it fails to do so, then that systemic identity perishes and the autopoietic system may transform itself (1) into another autopoietic system, with a new organization; (2) into an allopoietic system, owing to the loss of its autonomy; or else (3) it can disintegrate and disappear. Of course, if systems are closed and autonomous, they cannot be controlled or managed from outside. Among supporters of autopoiesis it is debated whether autopoietic systems could be, at least partially, steered or "governed." Radical constructivists reject such a possibility. On the contrary, Varela (1979) does not deny the existence of a control dimension of autopoietic systems, usually carried out by engineers. He reconciles autonomy (deriving from organizational closure) and control, arguing that they are complementary. However, this is not true because autonomy and control are not two different dimensions, but rather the same dimension in different degrees: maximum autonomy = minimum control.

Types of Autopoietic Systems

Autopoietic systems are a large set, comprising the subset of living systems. First-order autopoiesis is at cell level, the second-order is at a multicellular (organism) level, and third-order autopoiesis is at a multicellular set level, as social systems are. First- and second-order autopoiesis occur in the same kind of organizational space, that of the physical space of biology, while third-order autopoiesis occurs in the social space, which is usually defined as a

communication, or linguistic, or cognitive space, even if these three labels do not indicate exactly the same things. However, what is most interesting for our purpose now is that if autopoiesis can occur in different organizational spaces, then we can also find autopoietic systems in nonphysical and nonbiological space. This would confirm that the class of living systems belongs to, but does not identify with, the class of autopoietic systems. This is the path followed by Maturana (1978, 1980, 1981) and, with significant differences, by Luhmann (1990), who distinguishes psychic, biological, and autopoietic systems. On the opposite Zeleny (1996) equates social and biological systems under their autopoietic character, and, reversing the causal relation, argues that, because of its autopoietic nature, also biological systems are social systems. On the other hand, Fleischaker (1988) and Varela (1979, 1981) argue that autopoiesis should be limited to biological space, beyond which only a metaphorical usage is acceptable.

Boundaries

Autopoietic systems must have a clearly identifiable boundary, like a cell membrane, independent of both the internal production network and the environment. This property, like some others, has been neglected or weakened in subsequent developments of the autopoiesis paradigm. However it maintains a relevant role, because without precise boundaries, system identity, invariance, and closure become vague and uncertain, and the threshold between living and nonliving systems is no more an on/off state. By the theory of nearly decomposable systems (Simon, 1962), it may be said that under some sort of sensitivity, threshold linkages between the system and its environment are not significant and do not influence system operations and identity. The system simply remains invariant. Therefore, boundaries are identifiable and precise only over certain sensitivity thresholds. Beyond the difficulty of establishing the threshold values, autopoiesis literature lacks any proposal in this direction.

System, Organization, and Structure

During the 1980s, Maturana and Varela (1980) and Varela (1979) delved into the question of the difference between system, organization, and structure. In short, the organization is a network of relations between system components, and its invariance gives an identity to the system—that is, the class it belongs to. The structure is the concrete and observable manifestation of the organization: it is the system's existence in a given space. Lastly, the system is the concrete existence of an organization through a specified structure. Moreover, Maturana and Varela suggested this kind of conceptual differentiation for all systems theory and all types of system. Here is an example: suppose we can define a chair as a network of relations between components (i.e., a horizontal plane supported by at least one strut). That is the organization of the seat class. Since both plane and strut can be made of various materials (i.e., wood, iron, plastic,

etc.), each member of the seat class may have a different structure. A specific member of the seat class, together with its defined structure, is a system.

APPLICATIONS TO FIRMS

Invariance and Change

Of course invariance cannot pertain to employees, because they change very often, because they are not operations and because they are not produced by the system itself. An organizational network could be invariant with respect to roles, rather than to people. If people change but roles remain, then we can speak of an autopoietic system. There are, however, quite a few problems in that approach. First, within the context of an organization, roles are very ambiguous, equivocal, and ill-structured, and therefore defy any attempt at identifying a network of roles. It would be like speaking about a network of vagueness, because since Simon's early works (March & Simon, 1958) it has been clear that the definition and design of even very simple tasks constitute a difficult challenge to human rationality. Any version of the "Tayloristic dream" encounters the problem of bounded rationality (Simon, 1978). Second, recent organization theories no longer speak of roles, but rather of competencies: what is organized are competencies and not roles. And competencies are even more difficult to define than roles. At least they are much more generic and vague. That is all the more true for knowledge-based organizations, which are the trend in the industrial world. Moreover, neither routines (Nelson & Winter, 1982) nor decision-making (Janis & Mann, 1977) could be taken as invariant operations, because recent studies on cognitive maps (Weick, 1979; Weick & Bougon, 1986), ambiguity (March & Olsen, 1976), and equivocality (Sims & Gioia, 1986) argue that the heaviest and most dominant work in organizations is sense-making (Weick, 1995) rather than decision-making. Whenever possible, before taking a decision one needs to give sense to and make sense of the world. As a matter of fact, the situations where problems and actions are well structured and defined, regardless of their solvability, are the exception and not the rule. Rather paradoxically, emphasis on sense-making is sustained even by supporters of autopoiesis (von Krogh & Roos, 1996; Luhmann, 1990; Maturana, 1978; Winograd & Flores, 1986), but it is inexplicable how it corresponds with invariance.

Roles and competencies are all but invariant: they are continuously changing and hence no invariance is recognizable. In fact organizations are always in motion through departments, divisions, strategic business units, and the like, and they keep on redefining individual roles and competencies. Even if we were to accept searching for roles or competencies rather than for people, it would be impossible to recognize any invariance, except in very generic and meaningless terms. On the contrary, a large and growing part of organization and management science is stressing the relevance of change and development, and

many scholars point out that all organizations are always changing, more or less broadly. The scientific problem is to succeed in classifying and studying how incremental rather than radical changes, which often alternate with one other, do emerge and develop. There is only one answer to such criticism: if organizations maintain their unity and identity, then their change is only apparent, because they do so only to the extent that it does not entail a modification of their identity—that is, maintaining their invariance. However, we believe that the first part of that answer fails to deal with and conceals the crucial point: a prior definition and identification of invariance, or invariant relations. The second part instead is pure tautology: *organizations do only what they can do*.

Closure

Even if roles and behaviors were organized, it would be impossible to make a clear-cut division, separating people from roles and behaviors. It appears to be a rehashing of the old classical approach, which also separated people from formal roles. All nonengineering approaches to organizations, since that of human relations, emphasize that people enter organizations in their entirety and not only in a manner limited to the formal or predefined part of their being. Studies conducted in the 1960s and 1970s pointed to the role played by personality as a whole in organizational behavior and, consequently, in human resource management. Recent studies (Kets de Vries & Miller, 1984; Park, Sims & Motowildo, 1986; Weick, 1979, 1995) further underlined the impact of emotions and nonintentional cognitive processes. One could argue that all these factors are involved in internal recursive cognitive processes, and therefore the pure self-referential approach is not disturbed. This is not the case, because multiple membership is a characteristic of social systems: people belong to many different organizations at the same time, carrying their personality, emotions, and cognition everywhere. They are vectors in polluting self-organization and self-reference, which would leave each organization with a closed "self." *Simultaneous memberships break closures and pollute self-organization and self-reference*.

Boundaries

Identifying organizational boundaries is an old and recurring theme in organization theory, to which the dominant answer of late is that they are very unstable, vague, and arbitrary. Physical boundaries, the external walls of organizations, clearly do not matter. Juridical definitions leave the solutions fully open and vague. Accounting approaches are very partial ones, because they would include only people paid by the organization, but many people can extend the influence of an organization without receiving any payment. Yet from both a juridical and an accounting point of view, it is not clear what can be considered internal or external. Transaction cost economics (Williamson, 1975, 1985) shows that boundaries change frequently, depending on production and

transaction costs. Resource dependence theory (Pfeffer & Salancik, 1978), highlighting the role of both the power and requirements of effectiveness, argues that boundaries are highly disputable and changing. Recently, pointing to the growing trend of firms to construct interorganizational networks, scholars spoke of "boundaryless" (Ashkenas et al., 1995) or "borderless" (Jarrillo, 1993) organizations. Organizations have all but stable, precise, or objective boundaries. Lastly, it appears quite strange to view firms as operationally closed systems when all organizational science surmises, and is also suggesting, the opposite, as the only way to face and cope with the growing environmental uncertainty of our times. Authoritative reviews, journals, and magazines keep recommending that firms be opened up, as the sole way to survive in complex environments. Firms are all but closed systems, at least because they must search for effective and efficient resources and clients, as well as for technologies and current and potential competitors. Inputs and outputs still remain very important concepts for firms, because an error in their identification could cause their death. One might answer either that any change in inputs and outputs is to leave the system invariant, or that inputs and outputs change to the extent that they maintain the same autopoiesis. The first answer is erroneous, because nearly any change in strategy and in type of inputs and outputs almost invariably affects the organizational structure and design as well. The second one leads back to the same tautology: organizations do only what they can do.

Perturbations

The distinction between inputs-outputs and perturbations is one of the most problematic questions. First, some supporters of autopoiesis refer to the concepts of structural coupling between system and environment, which happens through perturbations. However, structural coupling is still a basic concept of first-order cybernetics (Ashby, 1956), and expresses the same meanings using inputs and not perturbations. What does it change, then? If it is not just a linguistic preference, then what difference is there between the structural coupling of first-order cybernetics and the structural coupling of autopoiesis? The second problem is that there is no ex-ante criterion of distinction between perturbations and input. In other words, a way to distinguish perturbations from inputs must be found independently and before the system's reactions, which could leave the system's organization untouched. It is necessary to be able to escape from such tautological definitions as "the system is autopoietic because it interacts with environments only through perturbations and not inputs."

In fact, since one may say also that "interactions are perturbations and not inputs because the system is autopoietic," given our lack of a way to distinguish perturbations from inputs or, independently, to distinguish auto- and allopoietic systems, we would fall into a tautology. The latter involves perfectly identifying the system's organization and then checking that it does not change after interactions with environments. Then we have to test all the other criteria that define a system as autopoietic. If the result is positive, we may say that the

interactions occurring between system and environment are perturbations and not inputs. Adopting this method, the criterion of distinction between perturbations and inputs is in terms of residual. In the alternative case, an independent criterion of distinction between perturbations and inputs would be simpler and would involve distinguishing auto- and allopoietic systems as well. However, the literature on autopoiesis does not offer any test or operationalization of either of the two alternatives, remaining encapsulated in tautology. Although recent literature on enactment, interactionism, and population ecology of organizations points to limits of adaptation feasibility, due to organizational inertia (Hannan & Freeman, 1989), recognition and activation selections (Weick, 1979), and problems of observation (Biggiero, 2001) and interaction (Zan, 1995), no one really rules out an environmental influence on a system, nor its partial ability to adapt.

Identity and Belonging

In Maturana's (1978) and Luhmann's (1990) perspective of autopoietic social systems, the question of identity is central, because it coincides with a system identification. The means to achieve such an identity is recurring self-reference: identity is the "fixed point," the "attractor" of its self-referring process. The problem, however, is that in order to converge to a fixed point the self-referring system must always contain the same elements. Now, if those elements are people, there is a multiple membership problem because each of us belongs to many different systems at the same time: families, lobbies, parties, and so on. All the organization sciences have traditionally argued that people enter organizations with their own unity, with their whole personality, and that they do not do so only to the extent required by their own role or competence. In any event, since both competence and personality are strictly related to what occurs in all the other systems to which anyone belongs, then the self-referential process can be only partial, and nobody knows whether it converges.

Membership is the most important property of social systems: people belong to many different systems. As a consequence, every time one identifies a social system, this is connected to someone else through "communication embodiments" (people). Therefore, however good one's capacities to make subtle and precise distinctions, these would "break" people. In mathematical terms, this means that all society is an enormous, single network, and that all systems we could define are subnetworks (subsystems). Multiple membership is just a cross-boundary property, because people are at the same time elements of different communication networks. Where is closure? In our minds? Are we schizophrenic and partitioned beings, so that we activate separate parts of our neuronal networks depending on the system we are immanently faced with? And are these parts speaking different languages and creating different meanings reacting to the same things? This is not my opinion, and I point to two issues. First, Wittgenstein considers language a public affair, and hence emerging from

inter-actions, which reciprocally influence nonclosed systems. Second, translation is a sign of openness.

Two More Questions

The theoretical perspectives of management sciences differ from the autopoiesis paradigm under two subtle but relevant aspects. The first refers to the difference between formal and empirical sciences. When we say that we define a system by applying a certain criterion, the system of course gains an identity and becomes "closed" to that criterion, because a criterion of distinction is per se an inclusion-exclusion criterion as well. It is merely saying that A=A. However, such a staticity, precision, and clarity concerns formal sciences but not empirical sciences, where identity and closure cannot be presupposed. They are just the object of inquiry; and a special object: an evolutionary one, whose future behaviors are quite complex (unpredictable). Hence, in empirical sciences, as management sciences are, no one knows ex-ante what the multidimensional definition (criteria of distinction) is that makes it possible to precisely identify (the borders of) social systems. It is merely conjectural knowledge, concerning how complex systems evolve and what their temporary identities and operations may be. As such, operational closure cannot be presupposed, but rather it is a hypothesis to be empirically tested. "Communication network" is definitely generic and does not permit any meaningful distinction. Whenever we attempt to operationalize definitions, we find that people belonging to the identified system communicate with people outside the system. Hence, no closure. The only solution is to refer to isolated communities somewhere in the world, which are actually like individual examples of mankind.

The second subtle difference between management sciences and the autopoiesis paradigm concerns the radicalism of the latter, which claims precise distinctions and on/off conditions. Living systems are supposed to be precisely distinguishable from nonliving systems, system identities are supposed to be precisely distinguishable from one another, boundaries are supposed to be clearly defined, and so on. Moreover, organizational closure is supposed to be as such 100%, as well as self-organization. After many decades of debate on organizational boundaries and a few years on organizational identity (Biggiero, 1998b), management sciences are assuming nonradical orientations. In other words, closure-openness, identity, self-organization, and boundaries are matters of degree and not of on/off states. Up to now we conclude that, under the characteristics we discussed, firms are not autopoietic systems, which was our first thesis.

SECOND-ORDER CYBERNETICS AND AUTOPOIESIS

Now we may ask ourselves whether second-order cybernetics needs autopoiesis, as this would seem to be the case considering the growing use of this term among systems theorists. I believe that there is no need for it, because

the characteristics that define autopoiesis are much more restrictive than those of second-order cybernetics. While autopoiesis is not applicable to firms and to social systems at all, second-order cybernetics can help towards understanding social systems, if concepts like self-organization, self-reference, and autonomy are interpreted as a question of degree and not as on/off conditions. Second-order cybernetics stressed some concepts already introduced by first-order cybernetics, like feedback functions and recursivity (Ashby, 1956), self-organization (Ashby, 1962), subjectivity of observations (Ashby, 1956), and such. Engineering culture and applications highlighted openness and control, underestimating sources of complexity (Biggiero, 2000). Second-order cybernetics has the benefit of reducing illusions of controlling living and social systems and of stressing self-organizing processes.

As frequently occurs in the history of ideas, a school of thought emphasizes and radicalizes what its predecessors ignored or denied. At the very core of second-order cybernetics there are: (1) self-organization, based on feedback properties; (2) system identity, based on a certain degree of organizational closure; (3) organizational closure, based on a certain degree of organizational boundaries; (4) nonrealistic or antirepresentationalist epistemology, based on the perspective of observer subjectivity; (5) and a new theory of knowledge, based on self-reference and relational complexity (Biggiero, 2001). Often these issues are collected and addressed as a new perspective in epistemology, called constructivism. Now, the point is that all these issues can hold true without claiming an extreme position. In no way does second-order cybernetics imply joining radical constructivism (or autopoiesis). A moderate constructivism is compatible with second-order cybernetics and with a "degree approach." Even postpositivist and antirealist epistemology are compatible with second-order cybernetics and moderate constructivism, while they are not compatible with relativism, idealism, skepticism, and radical constructivism (or autopoiesis) (Biggiero, 1998a). Ashby, Bateson, Klir, Wiener, and even Von Foerster can be usefully distinguished from Von Glasersfeld, Luhmann, Maturana, and Varela.

In management literature, explicit treatments of the applicability of the autopoiesis paradigm to organizations can be divided into groups. Kickert (1993) and Morgan (1986) argue for a limited metaphorical use, helpful mainly in highlighting the relevance of self-organizing processes and in explaining the formation of organizational identity and inertia. These are merely concepts that autopoiesis borrowed from second-order cybernetics. On the contrary, Kickert (1993) points out that "a serious limitation of the original formal model of autopoiesis is its notion of closedness, albeit closure on a higher meta-level of organization…. Yet the model of autopoiesis unfortunately suggested that organizational stability had something to do with closure" (p. 271). He concludes that "the possibilities of a strict conversion of the autopoiesis model into a valid model that can be used in the administrative sciences are limited. The usefulness of the model does not seem to lie in strict adherence to the original and literal translation, but rather in its power as a source of a creative lateral thinking. It can inspire highly interesting and relevant ideas" (p. 276).

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However, we know that once amended from operational closure, invariance and self-production, autopoiesis "retrenches" to second-order cybernetics. On the contrary, Zeleny (1996), von Krogh (von Krogh & Roos, 1996; von Krogh & Vicari, 1993), and Vicari (1991) explicitly do take sides on the autopoiesis paradigm. While Zeleny and Vicari point out operational closure and its consequences for management and organizations, Krogh focuses mainly on corporate epistemology—that is, on consequences for strategy and decision making deriving from a paradigm change in the theory of knowledge and of information. The traditional perspective encounters a new one, which is characterized by three basic aspects: (1) the world is not pre-given; (2) knowledge is connected to observation; and (3) information is not an object but an observer's state. Many interesting findings are discussed by von Krogh in the field of strategic management and corporate epistemology. Although this chapter is not intended to investigate epistemological aspects, we wish to stress that we agree with nearly all the ideas argued by von Krogh & Roos (1996), but they imply neither an antirepresentationalist epistemology, nor the autopoiesis paradigm. They are compatible with postpositivist orientations, and particularly with moderate constructivism and second-order cybernetics. Moderate constructivism has been applied to organizations, strategic alliances, and industrial districts (Biggiero, 1998b, 1999). Relative closure, multiple fuzzy boundaries, identity, and recursivity assume a sound meaning and match the literature in management and social psychology with no reference to autopoiesis.

CONCLUSIONS

Management literature regards organizations as systems which, through inputs and outputs, are open to changing environmental conditions. To ensure system survival, a fit must be found between system structure and environmental conditions. The autopoiesis paradigm, developing second-order cybernetics, goes to the opposite extreme: cognitive, living, and social systems are totally autonomous and operationally invariant. They "select" the environment, and not vice versa. Environmental perturbations allow for changes of system structure as long as these do not affect its operations, which guarantee system identity and closure. Such a perspective is not applicable to firms, nor to social systems. Although they have a significant and variable degree of autonomy, closure, and identity, in no way is it possible to radicalize these aspects as on/off and ex-ante conditions. Inputs cannot be distinguished from perturbations, and organizational boundaries are all but stable, precise, and independent. However, the recognition and study of those aspects of firms and social systems, if considered as matters of degree, can open up interesting research programs and easily join and integrate second-order cybernetics in the field of management. The former does not imply the autopoiesis paradigm or radical constructivism, and has everything to gain from separating their destiny, which would prevent a

further move of management sciences away from cybernetics, as we already have witnessed over the past three decades.

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