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Observing Systems: a Cybernetic Perspective on System/Environment Relations

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Descriptions of society have changed during the preceding decades. Expressions such as "knowledge society" or "information society" are nowadays generally used. In science, and social science in particular, the concept of information has entered as fundamental concept. It is no longer relegated to special fields of inquiry, such as public opinion research, mass communication or educational technology (cf. Craig, 1999). Instead, this concept, and the closely related concepts of communication and knowledge, are replacing the fundamental analytical categories of social action, social exchange, social role, etc. As is well-known, the entry of these concepts into the foundations of science after World War II coincided with the diffusion of new technologies of information processing.

It has been convincingly demonstrated that there is a relatively direct lineage from the early cybernetic information theories to the adoption of constructivist theories of information and communication in contemporary social theory (Hayles, 1999). In this paper, I want to argue that the potential of cybernetics has not yet been fully utilized. A careful (re)consideration of the insights of cybernetics opens up new horizons for social theory. The first sections of this paper will focus on the rise of second-order cybernetics and its constructivist epistemology. Special attention is paid to the epistemological consequences of the mathematical calculus of George Spencer Brown. Afterwards, I will highlight its impact on the writings of the sociologist Niklas Luhmann. In the final section, I argue for a redefinition of social rationality that incorporates the insights of second-order cybernetics.

1. AUTOPOIESIS AND COGNITION

Cybernetics is a relatively young scientific discipline. The publication of Norbert Wiener's *Cybernetics* in 1948 is often identified as the official start of the discipline. The subtitle of Wiener's book, *Control and communication in the animal and*

the machine, at the same time highlighted the subject matter of cybernetics, viz. regulatory processes in living organisms and thinking machines. The discipline focused on the formalization and modeling of information processing within systems-plus-environments.

The paradigmatic artifact of the young discipline was the homeostat. The homeostat was an electric device constructed with transducers and variable resistors. When it received an input changing its state, it searched for the configuration of variables that would return it to its initial condition. This homeostat was meant to model a system that must keep essential variables within preset limits to survive. From this cybernetic perspective, homeostasis indicated a universally desirable state, a requirement "uniform between the inanimate and the animate" (Ashby, 1953, p. 73; cf. 1956, pp. 195–201). Departure from homeostasis would threaten death for every living organism. The basic assumption was that a living organism is a mechanism that responds to its environment by trying to maintain its homeostatic stability or equilibrium.

This perspective attracted a lot of attention in the 1950s and 1960s, also among prominent social scientists (e.g. Claude Lévi-Strauss, Talcott Parsons). However, the assumptions encoded in the cybernetic artifacts did not go unquestioned. In the field of cybernetics itself, the epistemological status of the mechanistic models displaying input, output and feedback loops was put into question. How does information circulate between the mechanistic models and the people who make those models? As Gregory Bateson argued, the *observer* needs to be made part of the picture when studying the "cybernetic nature of self and the world" (M.C. Bateson, 1972, p. 16). In this "cybernetic epistemology," realist assumptions are replaced by constructivist assumptions. Following Gregory and Catherine Bateson, our knowledge is the end result of the internal processes we use to construct our inner world (perception, cognition). The inner world is a metaphor for the outer world. "Each person is his own central metaphor" (M.C. Bateson, 1972, p. 285). In an attempt to avoid the pitfall of solipsism, the Batesons also accorded an important role to objective constraints, for they insisted that only those constructions that are compatible with reality are conducive to long-term survival.

Gregory Bateson's objections to classical cybernetics were provoked by cybernetic research on information processing in living organisms. In breaking new ground, Bateson drew on a famous article on the frog's visual cortex, "What the frog's eye tells the frog's brain." Its authors had implanted microelectrodes in a frog's visual cortex to measure the strengths of neural responses to various stimuli. They registered that small objects in fast, erratic motion elicited maximum response, whereas large, slow-moving objects evoked little or no response. The frog's perceptual equipment allows it to perceive flies while ignoring other phenomena irrelevant to its interests. These results imply that the frog's perceptual system does not so much register reality as *construct* it. As the authors noted, while generalizing the results of their work, "it shows that the eye speaks to the brain

in a language already highly organized and interpreted, instead of transmitting some more or less accurate copy of the distribution of lights upon the receptors" (Lettvin, Maturana, McCulloch & Pitts, 1965, p. 251). In a recent discussion of these developments, Hayles aptly remarked: "No wonder that the article was quickly recognized as a classic, for it blew a frog-sized hole in realist epistemology" (1999, p. 135).

At the end of the 1960s, the fundamental problem for cybernetics was how to redefine homeostatic systems so that the observer could be taken into account. The breakthrough came with work that led to the publication of *Autopoiesis and Cognition* (Maturana & Varela, 1980). Humberto Maturana—also one of the co-authors of the article on the frog's visual cortex—arrived at his insights, he explains in the book's introduction, by deciding to treat "the activity of the nervous system as determined by the nervous system itself, and not by the external world" (1980, p. xv). His key insight was to realize that if the action of the nervous system is determined by its organization, the result is a circular dynamic. A living system's organization causes certain products to be produced (for example, nucleic acids). These products in turn produce the organization characteristic of that living system. To describe this circularity, he coined the term *autopoiesis* or self-production. A living system, then, responds to its environment in ways determined by its autopoiesis. It constructs its environment through the domain of interactions made possible by its autopoietic organization. A living system operates within the boundaries of an organization that closes in on itself and leaves the world on the outside.

The central premise of *Autopoiesis and Cognition*—that systems are informationally closed—radically alters the idea of the cybernetic informational feedback loop, for the loop no longer functions to connect a system to its environment. In the autopoietic perspective, no information crosses the boundary separating the system from its environment. We do not see a world "out there" that exists apart from us. Rather, we see only what our systemic organization allows us to see (see also Maturana & Varela, 1988; Maturana, 1997). The world merely irritates; it triggers changes determined by the system's own organization. This is expressed by the formula "order from noise." Only a closed system is able to know (the world). Moreover, "everything said is said by an observer" (Maturana & Varela, 1980, p. xxii; cf. von Foerster, 1978; Vanderstraeten, 1997).

But how do observing systems observe? In second-order cybernetics, one draws—conform to the discipline's background—on a mathematical calculus to clarify the basic operations of observing systems: George Spencer Brown's *Laws of Form* (1971). "The fundamental cognitive operation that an observer performs is the operation of distinction" (Maturana & Varela, 1980, p. xxii; see also Varela, 1979). Accordingly, the construction of the world depends upon the processing of distinctions (or, in Spencer Brown's terminology, on forms). When something is observed, it is indicated as being distinct from something else. The indication of one side of the distinction provides the system with information of the kind of:

this-and-not-that, this-and-not-something-else. The distinction divides the world into what is momentarily included and what is excluded. Following second-order cybernetics, it is the system's distinction that defines the meaning of what is observed. This implies that one needs to observe the system and the distinctions that it uses in order to analyze this system's universe. One needs to observe the observer and not the objective world. As Spencer Brown remarks: "Our understanding of such an universe comes not from discovering its present appearance, but in remembering what we originally did to bring it about" (1971, p. 104).

An example may clarify the background of this theoretical move. If a system intends to observe and describe processes of variability or change within its environment, it needs to use terms and sentences that cannot participate in, nor represent this variability. The terms and sentences it uses have to be interpreted to add the experience of variability. "When described, the variability is represented by constancy, namely by the time-independent describing sentences. It is when we interpret the sentences that we add the reality, the described variability" (Löfgren, 1981, p. 130). But if changes are described by means of constants, these constants contradict the (description of the) variability itself. An observing system cannot produce internal correlates of the dynamics of its environment. It can only orient itself to itself. It has to find its way by its own guidance. An observing system can only construct its own distinctions, such as fast/slow, variable/constant, before/after. It is, in Gregory Bateson's words, "a difference which makes a difference" (1972, p. 453).

This way, cybernetics starts a reflection upon the role of the observer in the observed universe. It abandons the subject/object distinction of traditional epistemologies and tries to include itself (as observer) among its objects (what is observed). It focuses on a description of the describer, on an observation of the observer, on a cybernetics of cybernetics. Cybernetics becomes second-order cybernetics. This switch is particularly clearly brought to the fore in the influential collection of essays by Heinz von Foerster, *Observing Systems* (1984). As the punning title already recognizes, the observer of systems can himself be constituted as a system to be observed. Before discussing the implications of second-order cybernetics, especially with regard to the study of ecological communication in society, I will review in greater detail Spencer Brown's differential logic (cf. Baecker, 1993, 1999).

2. LAWS OF FORM

In an extremely formal way, Spencer Brown defines observing as the application of a distinction. A distinction or form has two sides. It consists of a boundary that makes it possible to distinguish and separate both sides. The separation of the two sides makes it necessary to depart from one side of the distinction (the "marked state" or "inner space"), and not from the other (the "unmarked state"

or "outer space"). The observation must indicate what is being observed; a reference has to be given. Herein lies at the same time the hidden indication that there remains the other side which is (for the moment at least) not mentioned. If one thus equates observing with distinguishing, it becomes clear that the choice of a distinction entails important consequences. For example, the old tradition that distinguishes between humans and animals, and between animals and humans, has oriented both zoology and humanism towards a particular outlook on the characteristics of perfection, on deficits, on positions within the Creation, etc. The choice of a distinction is not an innocent event. It is already, as French philosophers would say, an act of violence (e.g. Derrida, 1979, pp. 117–228).[1]

This starting point is yet relatively simple—but it is built upon a complex foundation. Following Spencer Brown, an observation is an operation that applies a distinction to indicate one side of the distinction, and not the other. It encompasses two entwined components: distinguish-and-indicate. During the observation itself, these components cannot be separated nor blended. "We take as given the idea of distinction and the idea of indication, and that we cannot make an indication without drawing a distinction" (Spencer Brown, 1971, p. 1). This starting point raises the question about the position of the distinction itself. If the distinction makes it possible to indicate one of its sides, the distinction cannot contain itself. Every distinction has two sides, but is itself neither found on one, nor on the other side. The distinction itself remains *unobservable*, because it cannot be indicated as one of the sides of the distinction (Varela, 1975).

It is, of course, possible to distinguish distinctions. One can call a book expensive (and not cheap), new (and not used), slim (and not thick), exciting (and not boring), etc. But this distinction of distinctions does not solve but only postpones the problem. In this case, the distinction between distinctions cannot be found in itself, etc. Every distinction is a "blind spot," and this blindness is presupposed as the condition of the possibility of the observation. One can also say that an observation is inevitably *uncritical* with regard to its own reference.

According to Spencer Brown's account, the observation is at the same time a simple and a compound operation. It is a twoness which is an oneness: distinguish-and-indicate. It rests on the *distinction* between distinction and indication. This implies that one cannot start with making a distinction without already having made one. The first distinction is and is not the first distinction (Glanville & Varela, 1981; Kauffman, 1987). This paradox, however, does not paralyze Spencer Brown's calculus. The calculus starts with a simple directive which ignores the problem: "Draw a distinction" (1971, p. 3). The discussion of the paradox is postponed, until the calculus is sufficiently complex to introduce the figure of a "re-entry" of the distinction into the inner space, of the form into the form (1971, pp. 56–57, pp. 69–76; cf. Esposito, 1996). Thus, the calculus is able to account for circular or self-referential processes. It can reflect onto itself; it can observe its own observations (e.g. observe the distinction between distinction and indication). The calculus 'survives' its basic paradox, although it cannot eliminate

it. It unfolds its paradox. More precisely, its analysis of observations and descriptions ensues from the analysis of the problems of *self-observation* and *self-description*.

What gets excluded, from this point of view, is an universe which is entirely accessible to itself. In order to see itself, the world "must first cut itself up into at least one state which sees, and at least one other state which is seen. In this severed and mutilated condition, whatever it sees is only partially itself. We may take it that the world undoubtedly is itself (i.e. is indistinct from itself), but, in any attempt to see itself as an object, it must, equally undoubtedly, act so as to make itself distinct from, and therefore false to, itself" (Spencer Brown, 1971, p. 105). What gets excluded is an observation which is not constructed. The calculus cannot establish an outside perspective, an Archimedean position. But it allows for the calculation of the implications of particular distinctions via the operation of "re-entry." The operation of "re-entry" indicates the possibility of reintroducing the distinction which a system uses into its inner space, thus the possibility of directing the system's information processing by means of *the unity of the distinction* which it uses. To this point, I will return in the final section of this article.

3. OBSERVING SYSTEMS

Following second-order cybernetics, the world cannot be objectively represented within the system. It cannot instruct an observing system. The world is constructed. "The environment contains no information; the environment is as it is" (von Foerster, 1984, p. 263). The world is virtual information; only an observing system produces factual information. Every bit of information is an internal construct (von Foerster, 1999). I will indicate some important results of second-order cybernetics that bear upon ongoing epistemological debates, and then proceed to a discussion of the dominant modes of observing within contemporary society.

(a) Debates about the merits or defects of constructivism have hitherto predominantly focused on issues of construction versus representation (cf. von Glasersfeld, 1995; Gergen, 1998; Hacking, 1998, 1999). In different brands of constructivism, it is argued that reality is a construction and that this construction does *not* correspond with the external world. But what does this "not" mean? Why are observing systems not instructed by the world? Cybernetics provides a clear answer to these questions. It is the distinction between the marked state (what is indicated) and the unmarked state (what is not indicated) which is imagined by the observing system. An observing system explores which constructions or distinctions can be inscribed on the world. The contribution of the observing system, which allows for the construction of information, consists in the act of distinguishing. In other words: observations cannot copy, depict or represent an external reality

inside an observing system, because it is not possible to observe a reality that exists independent of the observation (that is, independent of the distinction drawn by the observing system).[2] The world "as it really is" is located in the unobservable "unmarked space" (Spencer Brown). In this light, the Batesons' idea of a metaphorical representation of the external world also needs to be given up.

(b) Constructivism redefines the concept of "resistance," which is traditionally used to underpin the referential capacity of knowledge. For Aristotle, *ta physika* are characterized by the resistance they oppose to us and they thus become objects of our cognition. It is, accordingly, by virtue of this resistance that we know them to be outside of ourselves and not illusions fostered upon us by our unreliable sensory apparatus. Without this resistance, we would never be able to ascertain whether the phenomenal or the sensible is really "out there" and thus whether we have any knowledge of such an "out there." Without this resistance, we would be free to imagine whatever we want. We would find no firm basis to stand on and be unable to make progress (i.e. to learn). In part, this classical line of argumentation can be maintained. But a constructivist theory of knowledge cannot situate this resistance in the external world. It has to focus on the resistance of constructions to constructions, on the opposition of observations to observations. The question is whether or not particular operations trigger further operations. Knowledge is self-dependent and self-reflecting (von Foerster, 1984, pp. 274–285; cf. de Man, 1986). Resistance is a problem of internal consistency. As a consequence, epistemological issues of correspondence need to be replaced by issues of *evolution and time* (cf. Spencer Brown, 1993; Miermont, 1995; Puddifoot, 2000).[3]

(c) From its foundational era onwards, cybernetics has emphasized the universal applicability of its basic concepts. Its theory of communication and control aims to apply equally to animals and machines. This implies that humans are primarily seen as information-processing entities who are essentially similar to thinking machines and other cybernetic artifacts. As indicated, the discipline's attention has shifted since the 1980s from the system's output behavior to the ways in which it instantiates processes of autopoiesis and cognition. But this shift has not reversed the cybernetic deconstruction of the human subject. For Maturana, the ongoing reproduction of a living organism's organization in interaction with its environment equalizes "cognition" (even if the organism is a worm). As will be discussed in greater detail in the following section, the German sociologist Niklas Luhmann (1995) has applied the concept of observation to autopoietic social systems, such as face-to-face interactions or the global society. Thus, cognition is not uniquely attributed to man (*animal rationale*); the abstractly defined cybernetic concepts enable divergent attributions of cognitive abilities. The subject literally loses its mind as the seat of reflective identity

(*cogito ergo sum*). This way, the evolution of cybernetics explains "how we became posthuman" (Hayles, 1999).

Following Spencer Brown's abstract definition, each observation depends upon a particular incision or distinction. An observation can only observe what can be observed by means of the distinction it uses. It cannot observe what it cannot observe. But this condition does not preclude the fact that the distinction that is used to observe is itself observed (if specified for psychological or social systems). An observation can reflect upon *another* observation. Moreover, an observation is able to distinguish and indicate what cannot be distinguished and indicated by a previous observation. In this case, the observation of observations is not directed towards *what* an observer observes but is interested in the way *how* an observer observes. This second-order observation focuses on the blind spot of an observer. The blind spot can be seen; it can be observed by another observer, or by the same observer at another moment in time (self-observation). Second-order observations focus on the instruments that are used, and on what these instruments make and make not accessible. They illuminate the way in which an observing system observes or constructs its world. But—and this is an important point—this second-order observation is also a first-order observation, in as far as it cannot distinguish its own distinction. The second-order observer does not have access to a privileged, holier-than-thou point of view. Rationality cannot be founded on some objective, external element; it has to be established "in the game."

4. THE DIFFERENTIATION OF SOCIETY

Since the 1950s, cybernetics has had a relatively strong impact on social science. At present, the construction of second-order cybernetics provides new opportunities for social theory, as the German sociologist Niklas Luhmann has demonstrated in a range of important publications that deal with highly diverse issues (e.g. organizations, religion, love, law, educational discourse, politics). Against the background of Luhmann's work, I will focus on the difference between society and its environment, and on the rationality of this ecological difference. The choice of this example reflects in the first place cybernetics' traditional concern with system/environment relations. It also allows for the indication of how cybernetics' new armamentarium can be put to use in social theory. Moreover, the study of ecological relationships is becoming increasingly important, while the changes which society brings about in the environment firmly hit back on social life and endanger society itself.[4]

Following Luhmann (1995, 1997), society is an autopoietic system that uses communication as its mode of reproduction. The system is closed with respect to the *meaningful* content of communicative acts. Meaning can be actualized only by circulation within the system of ongoing communications. The condition of

autopoietic closure does not imply that society exists without relations to its environment, or without observations of environmental events. Closure is the condition of the system's openness. But an autopoietic system can only resonate on the basis of its own frequencies. There can be no point-for-point coordination with environmental changes. The system of society produces only very selective interconnections between itself and its environment. It makes use of internal distinctions to observe its environment—such as the distinction between a normal, structurally anticipated course of operations, and a situation in which the connection of further operations is uncertain. That distinction makes it possible to define environmental changes, for example, as problems that need to be tackled, or as elements of uncertainty or ambivalence that can be allowed to rest. As said, it is the difference (within the system) which makes the difference (within the environment).

Luhmann's most important contribution consists, in my view, of his analysis of society's dominant mode of internal differentiation (cf. Luhmann, 1982, 1997; Vanderstraeten, 1999). Internal differentiation denotes the way in which a system builds subsystems, that is, repeats the difference between system and (internal) environment in itself. In contemporary society, function is the dominant principle of system building. Our society is differentiated into the political subsystem and its environment, the economic subsystem and its environment, the scientific subsystem and its environment, the educational subsystem and its environment, and so on. Each of these subsystems accentuates, for its own communicative processes, the primacy of its own function. Each establishes a specific, highly selective set of system/environment relations and *privileges its own directive distinction* (e.g. true/false, have/have-not, legal/illegal, rulers/opposition). Function systems are not differentiated as regions of being, but by means of their *modes of operating and observing*.

Its functional "division of labor" conditions the way society is able to observe and react to its environment. In important regards, this form of differentiation narrows society's attention span. Because every function system is solely responsible for its own function, it tends to observe its environment only in as far as this environment is relevant within its programmatic perspective. For example, as something that is worthwhile from a scientific point of view, as something that is of importance with regard to economic performance, as something that can be used to produce a work of art, or as something that might bear upon political success. Each function system employs some of its own operations to reduce the complexity of society's environment, but these different reductions cannot simply be added to obtain a complete picture of the environment. One may conclude that, due to its form of functional differentiation, society itself, as the encompassing social system, is ill-prepared to observe the range of effects it elicits in its environment.

Modern society primarily reacts to environmental problems through its function systems. Environmental problems disturb the internal dynamics and sensitivity of function systems like politics, science, economy, education, religion or law.

Sometimes this happens directly when resources dry up or catastrophes threaten. But it also occurs indirectly via socially mediated interdependencies when, for example, the economy is forced to react to legal precepts even if it would attain better results following its own ideas. In this sense, the form of functional differentiation also produces its own problems; it produces effects within the system of society, which are unlike the changes in the environment that originally triggered them. At present, the amount of resonance that is due to the different kinds of interdependencies of function systems seems to be much greater than the amount that results from society's relation to its external environment. This disequilibrium is also a consequence of the autopoietic organization and internal differentiation of modern society.

In a functionally differentiated (postmodern) society, as Luhmann has analyzed it, there is no supervening reason, no center, no apex, that would allow to steer the development of society and its connections with the environment. As we know, this structural limitation does not exclude that the political system is often called upon to direct the course of society, and that it airs itself its ambition to provide these guidelines. But the political system cannot regulate other function systems. It cannot steer the operations of other systems, because these operations depend on the construction of differences in the context of these other systems. Politics can only influence them in an indirect way, if changes in the political system change the environment of other function systems. As Luhmann critically remarks, it is precisely because it cannot do anything immediately, that the political system is likely to become the place where communication about ecological themes will find a home and expand. "The system enables and promotes loose talk. As we can read in the newspapers, nothing prevents a politician from demanding, proposing or promising the ecological adjustment of the economy. But a politician is not obliged to think and act economically, and so does not operate at all within the very system that his or her demand will ultimately bring to ruin" (Luhmann, 1989, p. 120). One can reformulate this insight in another, more positive way: claims about political rationality will have to include reactions to the effects of political decision-making in its calculations. In order to improve its connection with the environment, society needs to become aware of the way its communicative acts are observed and processed. Rationality, then, is conceived in terms of second-order observations.

5. ECOLOGICAL COMMUNICATION

Luhmann's theory of social systems has not gone uncontested. The objections to his analysis are partly provoked by the idiosyncratic idiom which he uses (and which makes translations of the original German writings so difficult and troublesome). The preceding section focused on Luhmann's utilization of the armamentarium of second-order cybernetics. By analyzing how he observes, that is, by observing

the distinctions which he employs, it becomes possible to deconstruct his approach. An objective standard or criterion to assess the scientific value of the approach fails. In line with a well-known pragmatist device, it needs to be argued that the usefulness of the approach is proved or disproved by its scientific outcomes.

Luhmann (1997) has indicated that his writings reflect the social condition of plurality and diversity. The so-called postmodern condition—the end of the *métarécits*, the equivalence of different types of discourse, the experience of contingency, etc.—makes second-order cybernetics possible, and *vice versa*. In our society, there is no ontological or social foundation for a transcendental or privileged holier-than-thou position. Knowledge always depends upon particular distinctions. But this condition does not preclude that the distinctions that are used to observe are observed, and that the question is raised why this and no other distinction is drawn. This way, one can safeguard the option of thinking and acting in *different* ways. This way, one can also find out whether cultural or structural factors privilege particular distinctions, and hide them from explicit examination.

But the analysis should not be restricted to "deconstruction." The preceding discussion of the ecological relations of society can be proceeded with a "constructive" aim in mind. At the moment, the system of society sharply reduces its relations with the non-social environment. The reference to the world is filtered not only by the external boundaries of the encompassing system but also by the internal boundaries of the function systems. It is this what the conditions of "Western rationalization" (Max Weber) hang on: the rationalization of intra-social arrangements. But this also implies that system-rationality increasingly loses its claim to be world-rationality. Guidance from internal environments, for example markets or public opinion, tends to dominate. To the extent that system-rationality appears more realizable it becomes less world-rational.

How, then, can a larger measure of environmental openness be attained? Perhaps, it is possible if society ameliorates its capacity for observing itself, that is, if it becomes aware of the reductive meaning-schemes it puts to use and improves its potential for second-order observations. Within society, observations of social distinctions (or observations of observations) have almost always taken place. Society's internal differentiation makes possible the observation of one subsystem by another. Nowadays, the politicians observe the economy, the law-makers observe politics, the artists observe the mass media, the journalists observe the economy, etc. One system's distinctions are thereby applied to other systems that do not use these distinctions to observe. But this is not a critical observation of itself. It remains external to the function systems themselves; it does not immediately influence a system's mode of observation. Self-observation occurs only on the condition that the observation does not distance itself from its object but co-intends itself.

The answer to the question of the world-rationality of society must be a change in the formulation of the problem. Rationality cannot refer to an end-state or goal. Society cannot be steered or planned by means of a particular teleological

rationality. From a cybernetic point of view, rationality refers to the distinctions which a system uses to operate and observe its environment. But where arises the rationality of a distinction? One can suggest that it results out of a reference to the ultimate difference of system and environment, i.e., out of an ecological difference.

Accordingly, a system attains rationality to the extent that it reintroduces the difference of system and environment within the system. Measured by this criterion, ecological rationality would be attained when society could charge the reactions to its environmental effects to itself. It would be attained when society could inculcate the consequences of its proper way of operating on the environment. Then, this principle would have to be reformulated with a corresponding system-reference for every function system in society.

Social rationality would require that the ecological difference between society and its external environment is reintroduced within society. As indicated by Luhmann, there is no privileged place, no authoritative organization or constitution that is able to transform the ecological difference into binding guidelines for further information processing in any of the function systems. There are no natural primacies; there are no privileged or non-competitive positions that are able to issue binding guidelines for the whole system of society. A centerless society cannot assert a rationality of its own but has to rely on the rationalities of its function systems. The possibility of reintroducing the difference of system and environment within the system, thus the possibility of directing the system's information processing by means of the unity of the difference of system and environment, depends upon the operations of the function systems. Each function system introduces in its own modes of operating the ecological difference of society and its external environment. It is only within the subsystems that the possibility exists of a hierarchical organization through which the difference of system and environment can be transformed into internal system directives.

As is well-known, society currently alarms itself with regard to its environmental conditions. The situation seems to call for urgency and speed; alarm finally means "à l'arme" [take up the arms]. We have not much time, approaching an either/or situation. But this is also a self-protective device. We have, then, not enough time for reflection. But before rushing towards answers, we need to carefully reflect upon the questions we pose, and upon the way in which we frame our problems. I have tried to indicate that second-order cybernetics provides the instruments for an in-depth analysis of the conditions of our postmodern society.

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NOTES

[1] Spencer Brown's differential calculus comes close to the trajectory explored by the French philosopher Jacques Derrida. For Derrida too, difference is constitutive of meaning. An object is not just what is asserted as a "positivity". It acquires full identity in relation to what it is not. Signs cannot only refer to themselves, but must also refer to those texts which are not present (1981a, p. 26). According to Derrida (1981b, p. 304), a thing is never complete in itself but only in relation to what it lacks. Here, it is only possible to point briefly to some remarkable similarities between both authors. A comparison of their work would require other, elaborate studies (cf. Luhmann, 1993).

[2] This argument also seems to be underpinned by Willard van Orman Quine's work on the function of language and language acquisition. In his well-known attempts at "naturalizing epistemology," Quine uses the details of the process of language learning to clarify epistemological questions (esp. Quine, 1960).

[3] The concern with time, with change and evolution, also penetrates John Dewey's work. Dewey describes the act of perception "as a temporal act," as a process of "choosing" (1979, p. 23). Perceived subject-matter "at every point indicates a response that *has* taken effect with reference to its character in determining *further* response. It exhibits what the organism *has* done, but exhibits it with the qualities that attach to it as part of the process of determining what the organism is *to do*" (1979, p. 20, italics are mine). "Habits" are, according to Dewey, the organic sediments of acts of stimulus construction. Habits store previous experiences, and in this sense they can be considered as the "basis of organic learning" (1986, p. 38). One can also say that the events within the organism-environment transaction become (more) meaningful events. Events change into objects, i.e., "events with meaning" (1981, p. 240). Further details of Dewey's arguments are discussed in Vanderstraeten & Biesta (1998).

[4] The way I discuss this issue is itself a consequence of recent developments in the field. Classical approaches in cybernetics assumed a fairly one-sided kind of relationship between system and environment. Systems were conceived as "endangered species." They had to adapt to their environment in order to survive (e.g. Parsons, 1966). After the formulation of the idea of autopoiesis, the *interaction* between system and environment has been brought to the fore. The focus has shifted towards the changes the system elicits in its environment (cf. Vanderstraeten, 2000).

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