6. Theory of a Different Order: A Conversation with Katherine Hayles and Niklas Luhmann

Niklas Luhmann, N. Katherine Hayles,
William Rasch, Eva Knodt, and Cary Wolfe

This discussion was conducted September 21, 1994, at the Institute for Advanced Study at Indiana University, Bloomington, where Niklas Luhmann was a guest Fellow for two weeks. Both Luhmann and N. Katherine Hayles were participating in a conference at the university later that week, organized by William Rasch and Eva Knodt, entitled "Systems Theory and the Postmodern Condition." As a basis for discussion and exchange, before the interview Hayles was given a copy of Luhmann's essay "The Cognitive Program of Constructivism and a Reality That Remains Unknown," and Luhmann was provided with a copy of Hayles's "Constrained Constructivism: Locating Scientific Inquiry in the Theater of Representation." The conversation was organized and moderated by William Rasch, Eva Knodt, and Cary Wolfe.

CARY WOLFE: I'd like to begin with a general question. In your different ways you have both explored a second-order cybernetics approach to the current impasse faced by many varieties of critique. And that impasse, to schematically represent it, seems to be the problem of theorizing the contingency and constructedness of knowledge without falling into the morass of relativism (as the charge is usually made) or, to give it a somewhat more challenging valence, without falling into philosophical idealism. You both have worked on this, and I'm wondering if each of you could explain, in whatever order you'd like, what makes second-order theory distinctive, and how it might help move the current critical debates beyond the sort of realism versus idealism deadlock that I've just described.

KATHERINE HAYLES: Would you care to go first?

NIKLAS LUHMANN: OK. Well, I reduce the general term "second-order" to second-order observing, or describing, what others observe or describe. One of the distinguishing marks of this approach is that we need a theory of observation which is not tied to, say, the concept of intelligence, the mind of human beings, but a more general theory of observation that we can use to describe relations of social systems to each other, or minds to social systems, or minds to minds or maybe bodies, to neurophysiological systems, or whatever. So, it needs to be a general theory of observing—and I take some of these things out of *The Laws of Form* of George Spencer Brown—to think of observing as an operation that makes a distinction and is then bound to use one side of the distinction, and not the other side, to continue its observations. So we have a very formal concept of observation. And the problem is then, if you link different observing systems, what can be a cause of stability, how can— in the language of Heinz von Foerster and others—*eigenvalues,* or stable points or identities, emerge that both sides of a communication can remember? And I think this is the idea which goes beyond the assumption that relativism is simply arbitrary: every observation has to be made by an observing system, by one and not the other, but if systems are in communication, then something emerges which is not arbitrary anymore but depends on its own history, on its own memory.

KH: For me, second-order theory would be distinct from first-order theory because it necessarily involves a component of reflexivity. If you look at first-order cybernetics, it's clear that it has no really powerful way to deal with the idea of reflexivity. In the Macy conference transcripts, reflexivity surfaced most distinctly in terms of psychoanalysis, which was threatening to the physical scientists who participated in the Macy conferences because it seemed to reduce scientific debate to a morass of language. When they would object to Lawrence Kubie's ideas, who was the psychoanalyst there, he would answer with things like "Oh, you're showing a lot of hostility, aren't you?" To them, that was almost a debasement of scientific debate because it kept involving them as people in what the conference was trying to do. There were strong voices speaking at that conference in favor of reflexivity—people like Gregory Bateson and Margaret Mead—from an anthropological perspective. But because reflexivity was tied up with psychoanalysis and the complexities of human emotion, it seemed to most people at the Macy conferences simply to lead to a dead end. When Maturana and Varela reconceptualize reflexivity in *Autopoiesis and Cognition,* they sanitize reflexivity by isolating the

observer in what they call a "domain of description" that remains separate from the autopoietic processes that constitute the system as a system. I think Professor Luhmann's work is an important refinement of Maturana's approach because he has a way to make the observer appear in a non–ad hoc way; the observer enters at an originary moment, in the fundamental act of making a distinction. Nevertheless, I think that the history I've just been relating is consequential—the point that you can get to is always partly determined by where you've been. The history of second-order cybernetics is a series of successive innovations in which the taint that reflexivity acquired through its connection with psychoanalysis has never completely left the theorizing of the observer as it appears in that tradition. This is quite distinct from how reflexivity appears in, say, the "strong program" of the Edinburgh School of Social Studies of Science, where they acknowledge that the act of observation is grounded in a particular person's positionality.

Reflexivity has been, of course, an ongoing problem in both science and the history of science. When reflexivity enters relativity theory, for example, it has nothing to do with a particular person's personality, cultural history, or language; it has only to do with the observer's physical location in space and time. Relativity theory is not reflexive, it is only relative. To try to arrive at a theory of reflexivity which would take into account the full force of the position of the observer, including personal history, language, a culture, and so forth, has been, I think, a very important and extremely difficult problem to solve. To me, it's essential to talk about the observer in terms that would take account of these positional and locative factors as well as the theoretical question of how is it that we can know the world.

cw: To what extent do you think that in their recent work, Maturana and Varela have tried to move in this direction? I'm thinking now of the collaboration of Varela and Thompson and Rosch in *The Embodied Mind,* but more broadly of the whole concept of embodiment in second-order cybernetics, which has certain affinities with Donna Haraway's work on this problem, which is very much in the register that you were emphasizing. I'm thinking, too, of the explicit derivation of an ethics at the end of *The Tree of Knowledge* from second-order cybernetics. To what extent, then, do you see much of this work moving in that direction, and if so, is it moving in the way that you would like?

kh: You know, it's difficult to try to coordinate all these works, because they seem to me all significantly different, maybe because I'm geared to

thinking about texts, and therefore about the specific embodiment of these ideas in the language they use. But to compare just for a moment *Autopoiesis and Cognition* with *The Tree of Knowledge*: in the latter the authors write for a popular audience, and in the process the work changes form. It goes from an analytical form into a circular narrative. And with that shift come all kinds of changes in their rhetorical construction of who the observer of that work is, as well as of themselves as observers of the phenomena that they report. In this sense, *The Tree of Knowledge* is more positioned. But it does not solve a problem also present in *Autopoiesis and Cognition*—that is, using scientific knowledge to validate a theory which then calls scientific knowledge into question. I'm thinking here specifically of "Studies in Perception: Reviews to Ground a Theory of Autopoiesis." Autopoiesis leads to a theory of the observer in which there is no route back from the act of observing to the data that was used to generate the theory in the first place. The problem is exacerbated in *The Tree of Knowledge*. Even as they move from a "domain of description" to a more capacious idea of a linguistic realm in which two observers are able to relate to each other, there arise other problems having to do with the work's narrative form.

WILLIAM RASCH: What is your reaction to this?

NL: Well, there are several reactions. One is that I have difficulties, regarding the later work, comparing Maturana and Varela. Maturana advanced in the direction of a distinction between the immediate observer and the observer who observes another observer. The "objective reality" is that there are things, or niches, which are not reflected in the immediate observer's boundaries. But on the other hand, if you observe that observer, then you see how he or she sees the world by making this distinction. But the limit of this type of thought is the term "autopoiesis" itself as a system term. Autopoiesis was another term for circularity, that was its beginning. Maturana talked about cells in terms of circular reproduction and then, after some contact with philosophers, used "autopoiesis," finding the Greek term more distinctive. But there remains in Maturana the idea that circularity is an objective fact, and so the problem of self-reference is not really confronted in the theory—not in the sense of, for example, the cyberneticians who would say that a system uses its output as input and then becomes a mathematical cosmos with immense amounts of possibilities which cannot be calculated anymore, as in Heinz von Foerster or Spencer Brown's discussion of a "re-entry" of the distinction into the distinguished. And there are, within these more mathemati-

cal theories, possibilities which are not visible, I think, in the writings of Maturana and Varela. They are too empirically tied to biology. And then of course we have always this discussion of whether one can use biological analogies in sociology or in psychology or not, which doesn't lead anywhere.

WR: I have a question. Professor Luhmann, you said that you wanted to find a definition of observation that is on a very formal basis, that does not only apply to consciousness, but to systems of all sorts. When you, Professor Hayles, talked about observation, the sense of an individual came out more because you were talking about the person's locality, the observer's situation. Do you have a sense that observation is tied strictly to consciousness? Or is observation also for you a more formal definition that can be applied to systems other than consciousness?

KH: For me, observation is definitely tied to consciousness. In Professor Luhmann's article "The Cognitive Program of Constructivism and a Reality That Remains Unknown," you have a paragraph where you're talking about the observer, and you list a series of things like a cell, a person, and so forth. On my own copy of that article I put a big question mark in the margin: can a cell observe? Of course, I realize that it's partly a matter of definition, and you're free to define the act of observation however you want. But, for me, a cell could not observe in the way I use the term.

EVA KNODT: Could you maybe clarify . . .

WR: Let's let Professor Luhmann clarify how a cell can observe.

NL: Well, it makes distinctions. It makes a distinction with input/output, what it takes in or what it refuses to take in, or a distinction about its own internal reproduction, to do it in a certain way and not in another way. I'm not sure whether making distinctions implies the simultaneity of seeing both sides, or whether it is just discrimination. The immune system discriminates, of course, but does it know against what it is discriminating? And if you require for a concept of observing that you see both sides simultaneously, and the option becomes an option *against* something, then I would not say that cells are observing or immune systems are observing. They just discriminate. But for me this is not very important. It would be very important for Maxwell's Demon, for example, that he can distinguish—or it, whatever it is, can distinguish—what belongs on which side. But it is hardly thinkable for us, because we are always using

meaning in constructing reality. So the problem is to think of distinction, of observation, without the idea of seeing out of the eyes, out of the corner of the eyes, the other thing which we reject or give a negative value. So we, psychologically and socially, use the idea of meaning, so that "observing" becomes a distinct characteristic. And there is a question, of course, of whether we should extend it. But this is I think a terminological . . .

EK: I have a follow-up here, because I also was puzzled in the beginning when I started reading your work about this use of observation, and how it is different from this metaphorical idea that one thinks one sees with the eyes. It's very hard to separate oneself from it. Where exactly do you see the advantage of widening this concept of observation to an extent that it is no longer located in consciousness?

NL: For me, the advantage is to make possible a kind of interdisciplinary commerce, a kind of transference of what we know in cybernetics or biology into sociology or into psychology. Saying that there are very general patterns which can just be described as making a distinction and crossing the boundary of the distinction enables us to ask questions about society as a self-observing system. What happens in a self-observing, self-describing system? This is not only a question for conscious systems. I mean, there are five or more billion conscious systems, and you cannot make any theory of society out of adding one to another or dissolving them all into a general notion like the transcendental subject. But you can make some headway, perhaps, by using the formal idea of observing, and of making distinctions, to understand a system that has a recursive practice of making distinctions and guiding its next distinctions by previous distinctions, using memory functions, and all this. There are formal similarities between psychic systems and social systems, and this is for me important in trying to write a theory, a social theory, of self-describing systems, in particular of society.

WR: Shall we move on to a topic that is perhaps broached more directly in the two articles, and that is the topic of reality. Based on your reading of each other, how would each of you distinguish your notions of reality from the other? Both of you use the term *reality*, and yet strict realists would not recognize the term as each of you use it. But how do you observe each other using the term *reality*? Either one of you start.

KH: I'll be glad to start. In Professor Luhmann's article I alluded to before, the sentence that I found riveting was this: "Reality is what one does not perceive when one perceives it." It was when I got to that sentence

that I thought I was beginning to grasp his argument because I fully agree with that, with one important reservation. I, too, agree that whatever it is that we perceive is different, dramatically different, than whatever is out there before it is perceived. If you want to call what is out there before it is perceived "reality," then we do not perceive it, because the act of perception transforms it. Where I would differ is with the distinction between reality and nonreality, the binary distinction which he uses so powerfully in a theoretical way. I am concerned about a fundamental error that has permeated scientific philosophy for over three hundred years: the idea that we know the world because we are separated from it. I'm interested in exploring the opposite possibility, that we know the world because we are connected to it. That's where I would distinguish the approach I take. It is not really even a disagreement; it's more a matter of where you choose to put the emphasis. Do you choose to emphasize the interfaces that connect us to the world, or do you choose to emphasize the disjunctions that happen as distinctions are drawn?

cw: Professor Luhmann, I imagine you would like to respond . . .

nl: This formulation has a kind of ancestry, and in former times was associated with the idea of existence, with the idea, to put it another way, that I see trees, but I don't see the reality of trees. And if reality refers to *res*, and *res* is the thing, then you have visible and invisible things—and that's the world. In this philosophical tradition, the problem simply was not possible to formulate. But the formulation that reality is what you don't see if you see something can be phrased in different ways. And one of these other possibilities is to say that reality emerges if you have inconsistency in your operations; language opposes language, somebody says yes, another says no, or I think something which is uncomfortable given my memory, and then you have to find the pattern of resolution. Reality is then just the acceptance of solutions for inconsistency problems, somewhat as, in a neurophysiological sense, space is just produced by different lines of looking at it, by internal confusion and then a solution to the internal confusion, which is in turn produced by memory that could not remember if it could not make differences in time. I am here now, but before I was in the hotel, and before that I was in the restaurant, and were this everything at the same moment, then I could not have any kind of memory. So time is real because it tries to create consistency and solve inconsistency problems. And this explains why reality is not an additional attribute to what you see, but is just a sign of successful solutions. This also helps us to see the historical semantics of reality. For example, "culture"

at the end of the eighteenth century is a term which is able to organize comparisons—regional ones (French, German, and so on, or Chinese or European) and historical ones—so that there is a new pattern, some striking insight that is possible because the compared things are different. And "reality," as a result of functional comparisons, is just this kind of insight. You needn't have a more abstract notion of culture or identity or society, or whatever, to be able to handle contradictions which otherwise would obstruct your cognition.

CW: Let me just ask, for clarification, is this reality to which you are referring here different from the reality which is a kind of a creation or accumulation of what you elsewhere call *Eigenvalues*, or is that in fact what you are describing?

NL: No, I think that is just another formulation.

CW: OK, all right. I'd like to come back to something you said, Professor Hayles, and ask you about this issue of connection versus separation that you're interested in. One of the things that's distinctive to me about second-order cybernetics—its central innovation, I think—is that it theorizes systems that are both closed *and* open: in Maturana and Varela, the attempt to theorize closure on the level of operations or organization, but openness to the environment on the level of structure. So, in a sense, isn't that a theory of self-referential systems which are nevertheless connected to the reality in which they find themselves?

KH: Well, for Maturana and Varela systems are connected by structural coupling. What that gets you in explanatory power is a way to explain the plasticity of systems and changes in structure. Where I have a fundamental difference with Maturana and Varela is in their assumption that there is no meaningful correlation between stimuli that interacts with receptors and information that the receptors generate. This may finally come down to religious dogma; I am of one faith and they are of another. I have studied the articles on perception which Maturana and his coauthors published on color vision in humans and on the visual system of the frog. I do not believe the data support his hypothesis that there is no correlation between inside and outside. It was a bold and courageous move to make that assumption, because it allowed them to break with representation and to avoid all of the problems that representation carries with it. It did get them a lot of leverage. But it's one thing to say there is no correlation, and another to say that the transformations that take place between the perceptual response and outside stimulus are transfor-

mational and nonlinear. The latter, I believe, is more correct than the former. I think it's important to preserve a sense of correlation and interactivity. This is primarily where I differ from them.

WR: Could I just follow up, and then maybe both of you could comment. You mentioned before that where you had differences, when you were speaking of Professor Luhmann's work, was with the assumption that knowledge of the world is attainable because of separation from the world. If now you're saying that there is some way of thinking of a correlation between an outside and an inside, doesn't that ontologize separation from the world, and doesn't that get you back into what you were trying to get out of—that is, the idea that we can only know the world because it is outside of us and it has causal effects on us through sensory perception? Doesn't that solidify the inside/outside distinction? Why not talk instead about closure and knowledge coming from the inside, where the inside/outside distinction is made in the inside, and there is thus a more fluid relationship between the two, where you know the world because you are the world?

KH: Well, if you allow the distinction to fall into an inside/outside, as it certainly can, then you're back essentially to realism in some form and also representation. What I was trying to do in my article on constrained constructivism was to move the focus from inside/outside into the area of interaction, where inside and outside meet. That precedes conscious awareness, but it is in my view an area of interaction in which, precisely, a correlation is going on between stimuli and response. So . . .

EK: Could you elaborate a bit? I have a problem here because you said a little earlier that whether or not you accept the idea of closure comes down to dogma or faith, and now you're referring to some observations that seem to confirm the model that you're proposing. Could you say a little bit more about what kind of evidence leads you to your particular choice?

KH: If we start from the frog article, which was the beginning for Maturana, what the article concludes (this is a near quotation) is that the frog's eyes speak to the frog's brain in a language already highly processed. It does not, however, show that there is no correlation between the stimuli and the response.

EK: Yes, but what is the status of this correlation? I mean, that's what the observer constructs as the frog's reality.

KH: Yes, that's right. That is, what is constructed is the frog's reality.

EK: From the human point of view.

KH: Yes. From the experimental point of view, to be more precise.

NL: But then you have the question, who is the observer? If it is a scientist, he or she can make theories and can see correlations, but if it's a frog itself, then things are different. Maturana talks about structural couplings and so on, but the frog as such constructs his reality as if it were outside, to solve internal conflicts. So, in this sense, the question is, why does a closed system like a brain need a distinction inside/outside to cope with its own problems, and why does it construct something outside that externalizes the internal problems of the workings of the brain, just to order his world, in which he himself is, of course, given?

WR: Can I follow up on that? This brings us to the notion of consistency, which Professor Hayles talks about in her article. And if I understand that correctly, the fact is that each one of us in this room would probably open that door to try to walk out of this room. We're all constructing the world based on internal contradictions, but it all happens to be the same world with reference to this room and these five people. How is that possible?

NL: Well, I think it would be—to take an example from the article of Professor Hayles—that if we jump out of the window we would contradict our own memory. We have never seen someone stop before they hit the ground, so we simply sort out our contradictions, as long as it is not necessary to change it, within the old pattern. So we go through the door and take the elevator, and this is reality as a solution of formal contradictions. Maybe we try once to jump from too high a place, but we never see apples or something stopping in the middle of the fall.

WR: So it's strictly experiential?

NL: It is just the solution of an internal conflict of new ideas or of variations within your memory.

WR: So in a sense, you both believe in constraints. If I understand you correctly now, Professor Luhmann, you would phrase constraints in terms of internal operations, especially memory, in this case. How do you, Professor Hayles, see the constraints that would prevent us from walking out of this window or trying to walk through that door? If you don't want to be a realist, and say because it's a door or because of gravity, how do you define what the constraints are?

KH: Well, the way I think about it is that "reality" already carries the con-
notation of something constructed, so I prefer to use the term "unmedi-
ated flux." The unmediated flux is inherently unknowable, since by defini-
tion it exists in a state prior to perception. Nevertheless, it has the quality
of allowing some perceptions and not others. There is a spectrum of pos-
sibilities that can be realized in a wide range of different ways, depending
on the perceptual system that's encountering them, but not every percep-
tion is possible. Therefore there are constraints on what can happen. We
can all walk out the door together because we share more or less the same
perceptual system—more importantly because we share language, which
has helped to form our perceptual systems in very specific ways.

WR: How does that differ from memory as Professor Luhmann described
it? In other words, I'm being very devious here in trying to coax the word
"physical" out of you. How can you describe what you're describing with-
out using the term "physical constraints"? Or are the constraints strictly
in the way the brain is structured?

KH: I believe there are constraints imposed by our physical structure; I
have no doubt of that. I think there are also constraints imposed by the
nature of the unmediated flux itself.

WR: What one would conventionally call the actual physical structure of
the unmediated flux?

KH: Yes, that's right.

NL: Then, if you use for a moment the idea that reality is tested by resis-
tance—that's Kant—how can you have external resistance if you cannot
cross the boundary of the system with your own operations? You cannot
touch the environment with your brain, and even if you touch it you feel
something here [points to his head] and not there, and you make an ex-
ternal reality just to explain that you feel something here [points again]
and not in other places on your body. So, finally, it's always an internal
calculation, otherwise you should simply refuse the term "operational
closure." But if we have operational closure we have to construct every re-
sistance to the operations of a system against the operations of the same
system. And reality then is just a form—or, to say it in other terms, things
or objects outside are simply a form in which you take into account the
resolution of internal conflicts.

EK: If that model holds, can you account for the historical emergence of
this idea that there is, and ought to be, a difference between the reality as

unmediated flux—what we do not perceive when we perceive—and the world of objects that we encounter in everyday life? I mean, does this idea itself have a similar function?

NL: I'm not sure . . .

EK: Starting with Kant, we find the distinction between the unknowable noumena and phenomena, where you locate some sort of reality outside and then you talk about constructed phenomenological reality. Could one apply this idea that you just mentioned—that reality has the function of neutralizing contradictions—to account for the emergence of this historical distinction?

NL: The emergence of this kind of internal distinction between inside and outside is even earlier. A system makes a distinction because it couples its own operations to its environment over time and has to select fitting operations, or it simply decays. Then, if it makes such a distinction, it has no way to handle the environment except by reconstructing or copying the difference between system and environment into the system itself, and then it has to use an oscillator function to explain to itself something either as an outcome of internal operations or as the "outside world." In Husserl it's clearer than in Kant, that you have noesis and noema, and you have intentions, and you can change between the two and put the blame on your own thinking or be disappointed with the environment. And to explain how our system copes with this kind of distinction, instead of just checking out how it is out there, we need an evolutionary explanation of how systems survive to the extent that they can learn to handle the inside/outside difference within the system, within the context of their own operation. They can never operate outside of the system.

WR: Do you have a response . . . ?

KH: This is not really so much a response to the thought that Professor Luhmann was just developing as a more or less independent comment. For me the idea of closure as reproduction of the organization of the system is perfectly acceptable. It seems like a wonderful insight. But I don't share the feeling Maturana and Varela have that organization is a discrete state. According to them, if a system's organization changes, the system is no longer the same system—it is a different system if its organization changes. It seems to me that organization exists, on the contrary, on a continuum and not as a discrete state. Consider, for example, evolution, in which all kinds of small innovations and mutational possibilities are

tried out in different environments. It's problematic when these mutational possibilities constitute a new species. Drawing distinctions between species is to some extent arbitrary, especially when there is an extensive fossil record. There are many instances in contemporary ecologies where it is impossible to say if an organism falls within the same species or constitutes a different species. Clearly the organizational pattern of that system has changed in a substantive way, enough to allow one to make a distinction, but the change falls along a spectrum. It is not black and white—either no change, or a completely different system. While it's an important insight to see that the living is intimately bound up with the reproduction of a system's organization, I don't see that it's necessary to insist there is a definitive closure in what constitutes an organization.

cw: The way I read Maturana and Varela's point is in a more cognitive or epistemological register, which is to say that if you observe something, you either call it X or not-X, X or Y, and that to cognize *at all* is to engage in the making of that distinction. Your description, it seems to me, is talking as if all these things are going on out there in nature, and then the question is, do our representations match up with them or not? That seems to me to be the pretty strongly realist and representationalist premise of the scenario you just described.

kh: Yes, but in this I don't differ in the least from Maturana and Varela, who are constantly using arguments based on exactly the kind of natural history case studies that I just mentioned in order to demonstrate the closure of the organism. I grant your point, that I'm assuming there is some way to gain reliable knowledge about these things. And of course it's always possible to open up scientific "facts"—or as Bruno Latour calls them, "black boxes"—and bring them into question again. But one has to argue from some basis.

wr: Can I ask you, Professor Luhmann, about your black box? In a sense, your black box is operational closure, beyond which you will not go. You do not want to dispense with it; it's the fundamental element of your system or your theory. As we discussed before, if we are talking about leaps of faith, that's your leap of faith. What is at stake in retaining operational closure? Why is it so important for your theory?

nl: Certainly, in sociological theory, or in social theory in general, you have the problem of how to distinguish objects or areas of, say, law, the economy, and so on. You can say that the economy is essentially coping with scarcity, or something like this. And to avoid these kinds of essentialist

assumptions, I try to say that the law is what the law says it is, and the economy is just what the economy in its own operation produces out of itself. This is, I think, the alternative, in which I try to opt for a tautological definition. And then I'm obliged to characterize how the operations of the system—say, communication as the characteristic operation of society—follow a certain binary code, like legal versus illegal, to be able to reproduce, say, the legal system. Recursive decision making reproduces an organization. But then I have this problem: I do not share the opinion of Maturana and Varela that outside relations *are* cognition, that you have already a cognitive theory if you say "operational closure." Maturana and Varela present structural coupling, structural drift, and these terms as cognitive terms. But I would rather think that a system is always, in its operation, beyond any possible cognition, and it has to follow up its own activity, to look at it in retrospect, to make sense out of what has already happened, to make sense out of what *was* already produced as a difference between system and environment. So first the system produces a difference of system and environment, and then it learns to control its own body and not the environment to make a difference in the system. So cognition then becomes a secondary achievement in a sense, tied to a specific operation which, I think, is that of making a distinction and indicating one side and not the other. It's an explosion of possibilities, if you always have the whole world present in your distinctions.

wr: OK, maybe we should move on to the topic of negation. Could you summarize for us, Professor Hayles, your use of the semiotic square in your notion of double negation in your article on constrained constructivism?

kh: I don't know how to give a short answer to this, so I'll have to give the long answer.

wr: Good.

kh: As I understand Greimas's work, he developed the semiotic square in order to make simple binaries reveal complexities that are always encoded in them but that are repressed through the action of the binary dualism. The idea is to start with the binary dualism and then, by working out certain formal relationships, to make it reveal implications that the operation of the binary suppresses. To give you an example, consider Nancy Leys Stepan's article about the relation between race and gender in physiognomic studies in the late nineteenth and early twentieth century. Stepan notes the circulation within the culture of expressions like "women are the blacks of Europe." To analyze this expresession, consider a semiotic

square that begins with the duality "men and women." What implications are present in that duality which aren't fully explicit? Some of those implications can be revealed by putting it in conjunction with another duality, white/black. By using the semiotic square and expanding the men/women duality, it is possible to demonstrate, as Ronald Schleifer and his coauthors have done, that "men" really means "(white) men" and "white" really means "white (men)." By developing formal relationships of the semiotic square, one can make the duality yield up its implications. It is important to remember that there is no unique solution to a semiotic square. Any duality will have many implications encoded into it, connotations which are enfolded into that duality but which are not formally acknowledged in it. So there are many sets of other dualities that can be put in conjunction with the primary one. If they're doing the work they should do in a semiotic square, each second pair would reveal different sets of implications. This is a preface to explain what I think the semiotic square is designed to do. Beyond this, the semiotic square is formally precise. It is Greimas's hypothesis that there are certain formal relationships that dictate how dualities develop. So it's not arbitrary how the relationships within the square are developed.

In the semiotic square I used, I wanted a binary which is associated with scientific realism: true and false. If a hypothesis is congruent with the world it's true. Popper argued that science cannot prove truth, only falsity. According to him, a hypothesis must be falsifiable to be considered scientific. The true/false binary is rooted in scientific realism. In order to have the "true" category occupied, you have to be in some objective, transcendent position from which you can look at reality as it is. Then you can match your hypotheses up with the world and see if the two are congruent. Thus the true/false binary comes directly out of realist assumptions. The binary I proposed to complicate and unravel the true/false dichotomy with was "not-false" and "not-true." I claim that the "true" position cannot be occupied because there is no transcendent position from which to say a hypothesis is congruent with reality. The "false" position *can* be occupied, because hypotheses can be falsified, as Popper argued. More ambiguous is the "not-false" position. This position implies that within the realm of representations we construct, a hypothesis is not inconsistent with the unmediated flux. Notice it is not true, only consistent with our interactions with the flux. Even more ambiguous is the "not-true" position; it represents the realm of possibilities which have not been tested, which have not even perhaps been formulated, and which may never be formulated because they may lie outside the spectrum of

realizable experiences for that species. It is this position on the lower left of the square, the negative of a negative, that is more fecund, for it is the least specified and hence the most productive of new insights. Hence Shoshana Felman's phrase for it, "elusive negativity."

CW: It's very important to you, it seems to me, to insist that those other possibilities that are opened up are not solely possibilities dependent upon the context of inquiry. This goes back to what you were talking about earlier with the unmediated flux containing or acting as a constraint, a finite set of possibilities—that's what these constraints finally are. So it's important to you to insist, versus say Maturana, that these unfolding possibilities do not tell us only about the *context* of inquiry, but about the object of inquiry. Would that be fair to say?

KH: Yes. That would be true to say.

WR: What is your reaction to the schema?

NL: Well, again, a long one. The first is that I would distinguish between making a distinction and positive/negative coding, so that negation comes into my theory only by the creation of language, and with the special purpose of avoiding the teleological structure of communication, its tendency to go by itself to a fixed position, to a fixed point, to a consensus point. So, if we have a situation in which every communication can be answered by "yes" or by "no"—I accept or I reject your proposal—then every selection opens again into either conformity or conflict. So, negation in this sense comes into my theory of society only by coding language, or doubling language so to speak, in a "yes" version and a "no" version. And of course it is important that you have the identity of the reference, the possibility to say "yes" or "no" to the same thing, and not to something else. I say "this is a banana," and you can say yes or no, but if you think that maybe it is an apple, then you have to make a distinction to talk about this. So this concerns negation. But I have also, independently of this, thought about an open question concerning distinction: distinction from what? And there are in principle, I think, two possibilities: distinction of an object from an unmarked space, from everything else (again, this is not a glass of wine, and not a tree, and so on). So, one type of distinction is that you create an unmarked space by picking out something. But then there is another type of distinction where you can cross the boundaries—male/female, for example, or in this example, true/false. And then you can oscillate between the two, and say, well, this is a job for a man or a job for a woman, is this good or is this bad, is this

expensive, given our budget, and so on. But if you *can* indicate both sides by this distinction, then you also create by this very distinction an un-marked space, because then you can change from the distinction true/false to the distinction good/bad. Or to the distinction male/female. And then you can make a kind of correlation or coupling between different distinctions. But this always creates the world, creates an unmarked space, a kind of thing which you cannot indicate. Or if you indicate the unmarked space, then you have two marks, marked and unmarked.

WR: Then you'll have another unmarked space . . .

NL: Yeah, yeah, then you create another unmarked space beyond this dis-tinction. And if I look at this fourfold scheme of Greimas's, I think that first it is quite clear that false/true is a specifiable distinction, specifiable on both sides. You can give arguments for true and you can give argu-ments for false, and you can have true arguments that something is false and false arguments that something is true. In this sense, it is complete. But then, when you make this distinction you also specify the unity of this distinction—which is, I would say, the code of science—and then you do not use, say, a political code (powerful or less powerful), or the gender code, or the moral code, or the legal code, or the economic code, or whatever. And when I look at this enlargement, I wonder whether it would be possible to say that indeed the false/true distinction is *not* a complete description of the world, that it leaves out the unmarked space, or it leaves out what you do not imagine, what you do not see, what you do not indicate, if you operate within this kind of framework. And this is important for my theory of functional differentiation, because if I iden-tify codes and systems, then of course I need always a third value or third position: the rejection of all other codes. So, if I am in the legal code, then I am not in the economic code; the judge doesn't make his decision ac-cording to what he is paid for his decision . . .

CW: Sometimes! [laughter]

NL: Well, yes, but then that's a problem of functional differentiation. And if I look at Greimas's table with its four positions, I think first that the lower line, the "not-true" and "not-false" line, is simply representing the unmarked space. Then I would change the positions; in other words, I would make the distinction between "false" and "not-false." "False" is something which is verified as "false"; "not-false" is everything else. Or "true" and "not-true." I don't know whether this makes any sense, but the essential point is that for my theory, especially for the theory of functional

differentiation, we need something which Gotthard Guenther would call "transjunctional operation"—that means going from a positive/negative distinction to a metadistinction, rejecting or accepting this kind of distinction. And you can, of course, have a metadistinction, then a meta-metadistinction, and that would always mean "marked/unmarked." And at that point, of course, you are in the middle of the question of how systems evolve by marking, by making marks in an unmarked space, and then you can have a history of possible correlations between structural developments and semantic developments in the history of society.

EK: Now your reinterpretation of this scheme, Professor Hayles, makes it look like it can no longer fulfill the function that, as I understand you, it's supposed to fill: namely, as far as I understand it, it's supposed to somehow assure us that we can somehow reach out of language and get language into contact with some sort of physical constraint. And when you interpreted the scheme . . .

WR: Negation is simply part of . . .

EK: . . . part of the inside. Then you don't need a constraint anymore. I mean . . .

NL: . . . self-imposed constraint . . .

EK: . . . in your reinterpretation of the scheme you get rid of the external constraints, and I think I have trouble really understanding how we can reach, with the square, the idea of an external constraint.

WR: I guess the question is, how? What evidence does double negativity give? What evidence not only of the outside world, but in a sense what evidence does double negativity give that it does deal with . . .

KH: It does not give any evidence, I think. I did not intend to say that it gave evidence. But Professor Luhmann was, I think, exactly right in identifying something in that second line with what he calls the unmarked, that which lies outside distinction, and that's exactly the category that I meant to designate by "not-true." "Not-true" is absence of truth, which is not to say that it's untrue; it's to say that it is beyond the realm in which one can make judgments of truth and falsity. It's an undistinguished area in which that distinction does not operate. So his idea of distinctions is very applicable to what I was trying to do there. What I was trying to ask was, is there a place in language that points toward our ability to connect with the unmediated flux? This does not prove that the unmediated flux

exists; it does not prove that the unmediated flux is consistent; it does not prove that the unmediated flux operates itself through constraints. It's simply asking the question, if we posit the unmediated flux, then where is the place in language that points toward that connection? That place is "not-true" or "elusive negativity," because that's the area in language itself which points towards the possibility I'm trying to articulate as "unmediated flux." It's no accident, I think, that in Greimas's article on the semiotic square he talks about this position emerging through the constraints that are present in the structure of language itself. In other words, his idea is that the structure of the semiotic square is not arbitrary; it's embedded in the deep structure of language. That, of course, is a debatable proposition. But just say for a moment that we accept the proposition. Then my argument is that the structural possibilities offered to us by language contain logically and semantically a category which points toward something we cannot grasp but is already encoded into our language.

cw: Can I jump in here at this specific point? What I hear you saying is that language as such does not presuppose any particular referent, but it does presuppose reference as such, right? Would that be fair?

kh: Well, I don't know that I was saying that. I thought I was saying that language has a logical structure, and part of that logical structure is to provide for a space for the unknowable and the unspeakable, even though paradoxically that space has to be provided within the linguistic domain.

cw: Right, but it's presupposed that it could be knowable and could be speakable, and moreover that that knowable and speakable is finite, right?

kh: The knowable and the speakable . . .

cw: . . . or contains a finite set of applications in language.

kh: What is in the category "absence of truth" could always be brought into the category of either "not-false" or "false." It would be possible to have a scientific theory which brings something which was previously unthought and unrecognized into an area of falsifiability. But no matter how much is brought into the area of falsifiability, it does not exhaust and cannot exhaust the repertoire of those possibilities. So, this goes back to Professor Luhmann's idea that there is a complexity outside systems which is always richer than any distinction can possibly articulate.

cw: I guess the difference that I'm trying to locate here is that, in Professor Luhmann's scheme, this outer space is automatically produced by

the deployment of distinctions—marking produces an unmarked space—but the difference is, in principle it seems to me, your claim about constraint, as we talked about it earlier: that it depends upon this set being finite. For you, it's not possible in principle to just go on and on and on deploying yet another distinction.

KH: Right.

CW: Because otherwise the claims about reality and the constraints that it imposes seem to me to fall apart at that point.

KH: Well, here maybe I can invoke some ideas about mathematics and say that I'm not sure the range of things that can be brought in to the realm of "not-false" and "false" is finite. It may be infinite, but if it is infinite, then it is a smaller infinity than the infinity of the unmediated flux, and as you know, Cantor proved the idea that one infinity can be smaller than another. So, if it's an infinity, it is a smaller infinity than the set of all possibilities of all possible constructions.

NL: In my terms, you would then have the question, what do you exclude as unmarked if you make the distinction between infinite and finite? [Laughter] But that's a book of Philip Herbst from the Tavistock Institute entitled *Alternatives to Hierarchies*, where he refers to Spencer Brown and raises somewhere the question, what is the primary distinction? You could have the distinction finite/infinite, you could have the distinction inside/outside, you could have the distinction being/not-being to start with, and then you can develop all kinds of distinctions in a more or less ontological framework. And I find this fascinating, that there is no exclusive, one right beginning for making a distinction. The classics would of course say "being" and "not-being," and then the romantics would say infinite/finite, and systems theory would say inside/outside. But how are these related? If you engage in one primary distinction, then how do the others come again into your theory or not? This is part of the postmodern idea that there is no right beginning, no beginning in the sense that you *have* to make one certain distinction and you can fully describe the start of your operations. And that's the background against which I always ask, "What is the unity of a distinction?" Or "What you do exclude if you use this distinction and not another one?"

CW: For me at least, the interest of your work, both of you, is that it is trying to take that next step beyond the mere staging or positing of incommensurable discourses. It seems to me that both of you—in finally some-

what opposed ways—are trying to move beyond this paradigmatic type of postmodern thought and move on—in your case, Professor Luhmann—to what you call a universally applicable or valid description of social systems. And in your case, Professor Hayles, that effort is revealed in your attempt to work out this problem of constraints—in a way, to try to rescue some sort of representationalist framework—to say that in fact there is a reality out there that does pose constraints and, moreover, can be known in different and specifiable ways by these discourses. It's possible, in other words, to see beyond that incommensurability . . .

KH: Yes, though I would not say—this sounds like a nit-picking correction, but to me it's the essence of what I'm trying to say—I wouldn't say that what is out there can be known; I would say our interaction with what is out there can be known.

CW: Then I think the question has to be, for me at least, in what sense are you using the term "objectivity" at the end of the "Constrained Constructivism" essay? A point that Maturana makes in one of his essays is that to use the subjective/objective distinction is to automatically presuppose or fall back on representationalist notions, which immediately recasts the problem in terms of realism and idealism.

KH: I don't use the word "objectivity."

CW: I have the *New Orleans Review* version . . .

KH: I don't think I use it in that essay . . .

CW: "In the process,"—this is about three paragraphs from the end . . .

KH: . . . oh, OK . . .

CW: ". . . in the process, objectivity of any kind has gotten a bad name. I think this is a mistake, for the possibility of distinguishing a theory consistent with reality, and one that is not, can also be liberating"—and you go on to talk about how this might be enabling politically, which is, I think, interesting because it does accept the challenge of moving beyond just saying, "well it's all incommensurable."

KH: Here, I accept the kinds of arguments that have been made by Donna Haraway and Sandra Harding about "strong objectivity," that to pretend one does not have a position is in fact not being "objective," in the privileged sense of "objective," because it ignores all those factors that are determining what one sees. And to acknowledge one's positionality,

and explore the relationship between the components that go into making up that position and what one sees, in fact begins to allow one to see how those two are interrelated, and therefore to envision other possibilities. Sandra Harding's formulation of "strong objectivity" takes positionality into account, and is therefore a stronger version of objectivity than an objectivity that is based on some kind of transcendent nonposition.

cw: Let me follow up here. I guess the problem I have, and this is the case with Harding's work, is that what you're describing is inclusion. I see how that means more democratic representation of different points of view, but I don't see how it adds up to "objectivity" in the sense that it's usually used. Unless the sense of objectivity here is procedural, that we all agree to follow certain rules of a given discourse.

kh: As a philosopher, Harding doesn't want to relinquish the term "objectivity."

cw: Yes, that's quite clear.

kh: I don't have any vested interest in keeping the word "objectivity," but I think the idea of what she's pointing to, whether one calls it "objectivity" or not, is no matter how many positions you have, they will not add up to a transcendent nonlocation.

cw: Right. The God's-eye view.

kh: P_1 plus P_2 plus . . . P_n is not God.

cw: Right.

wr: So actually what you're talking about is what you mentioned in the very beginning: the word "objectivity" basically means "reflexivity"—the reflexivity that you were missing in the early cybernetic tradition?

kh: Yes. I don't know if anybody's used the word "strong reflexivity," but I would like to. Strong reflexivity shows how one can use one's position to extend one's knowledge. That's part of what is implied in the idea that we know the world because we are connected to it. Our connection to it is precisely our position. Acknowledging that position and exploring precisely what the connections are between the particularities of that position and the formations of knowledge that we generate, is a way to extend knowledge. There is a version of reflexivity that, in the early period of science studies, was like an admission of guilt: "Well, I'm a white male, and so therefore I think this." There was a period when you couldn't write

an article without including a brief autobiography on who you were. But that really missed the point, because the idea is to explore in a systematic way what these correlations are, and precisely why they lead to certain knowledge formations, and therefore to begin to get a sense of what is not seen.

NL: Then my opponent should be not so much for the term "objectivity," but for the term "interaction," and who sees the interaction.

WR: Interaction between us and an environment . . .

NL: Yeah, yeah. I have no trouble in posing external observers, a sociologist who sees an interaction between the capitalistic economy and the political system, or between underdeveloped countries—center/periphery, and so on—but how could we think that the system that interacts with its environment is itself observing the interaction as something which gives a more or less representational view of what is outside? How can we see this without seeing that this is a system which does the observing? How could we avoid involving the system—which means a radically constructivist point of view—when we ask the question, "who is the observer?" We say "the outside observer, of course." He sees interactions of any kind, causal or whatever, as objective reality in *his* environment, because *he* sees it. But if the system *in* interaction tries to *see* the interaction, how could we conceive this?

KH: There may be many ways to use the word "interaction," and I'm not sure I'm using it in the sense you mean. For me, when I say the word "interaction," it already presupposes a place prior to observation, whether self-observation or observation by someone else. It's the ultimate point that we can push to in imagination, it's the boundary between the perceptual apparatus and the unmediated flux, and as such it is anterior to and prior to any possible observation. So, I would say that the interaction is not observable.

NL: Then you can drop the concept.

KH: You could drop the concept, except then you have a completely different system. What interaction preserves that I think is important is the sense of regularities in the world and the guiding role that the world plays in our perception of it. If representation and naive realism, with their focus on external reality, only played one side of the street, Maturana's theory of autopoiesis, with its focus on the interior organization of systems, only plays the other side. I am interested in what happens at the

dividing line, where one side meets the other side. Maturana's theory is important for me because it shows, forcefully and lucidly, how important perception and systemic organization are in accounting for our view of the world. It also opens the door to a much deeper use of reflexivity than had been possible before—an insight significantly extended by your positioning of the observer as he (or she) who makes the distinctions that bring systems into existence as such. But for me, this is not the whole picture. If it is true that "reality is what we do not see when we see," then it is also true that "our interaction with reality is what we see when we see." That interaction has two, not one, components—what we bring to it, and what the unmediated flux brings to it. The regularities that comprise scientific "laws" do not originate solely in our perception; they also have a basis in our interactions with reality. Omitting the zone of interaction cuts out the very connectedness to the world that for me is at the center of understanding scientific epistemology.

wr: Well, I think that we've hit that outer limit right here, where we are redefining boundaries. Do we have any other general questions? Maybe the system in question ought to be dinner . . .

cw: Let me just ask one more very general question, since we're on this point, and it's something we've touched on. At the end of the "Constrained Constructivism" article, Professor Hayles, you make it clear that this rethinking you're engaged in has pretty direct ethical imperatives. Objectivity, for you and for Sandra Harding and for Donna Haraway, is an ethical imperative as well as an epistemological or theoretical one, and you go on to specify what those imperatives are. I take it for you, Professor Luhmann, that you want to be very careful to separate ethics as just one of many social systems from other types of social systems, all of which can be described by systems theory. So what I'm wondering is, could you all talk a little bit about what you see as the ethical and political imperatives, if there are any, of second-order theory, to reach back to where we started.

kh: I don't know that I really have anything to add beyond what you just said, but it is clear for me that there are ethical implications of strong reflexivity and strong objectivity. I'm not really versed in ethics as a kind of formal system, so I'll defer that to Professor Luhmann.

nl: Well, for me ethics or morality is a special type of distinction, and a particularly dangerous one, because you engage in making judgments about others—they are good or bad. And then if you don't have consen-

sus, you have to look for better means to convince them or to force them to agree. There is a very old European tradition of this, the relation between standards and discrimination. If somebody is not on your side, then he is on the wrong side. And I think my work is a sociologist's way to simply reflect on what we engage in if we use ethical terms as a primary distinction in justifying our cognitive results: if you accept this you are good, and if you don't, you have to justify yourself.

Works Cited

Brown, George Spencer. *Laws of Form*. 2d ed. Reprint, New York: Dutton, 1979.

Greimas, A. J. "The Interaction of Semiotic Constraints." In *On Meaning: Selected Writings in Semiotic Theory*. Translated by Paul J. Perron and Frank H. Collins. Minneapolis: University of Minnesota Press, 1987.

Guenther, Gotthard. "Life as Poly-Contexturality." In *Beiträge zur Grundlegung einer operationsfähigen Dialektik*. Vol. 2. Hamburg: Meiner, 1979.

Haraway, Donna J. "Situated Knowledges: The Science Question in Feminism as a Site of Discourse on the Privilege of Partial Perspective." *Feminist Studies* 14 (1988): 575-99.

Harding, Sandra. "Eurocentric Scientific Illiteracy—A Challenge for the World Community." Introduction to *The "Racial" Economy of Science*. Bloomington: Indiana University Press, 1994.

Hayles, N. Katherine. "Constrained Constructivism: Locating Scientific Inquiry in the Theater of Representation." *New Orleans Review* 18, no. 2 (spring 1991): 76–85.

Heims, Steve Joshua. *Constructing a Social Science for Postwar America: The Cybernetics Group, 1946–1953*. Cambridge: MIT Press, 1993.

Herbst, P. G. *Alternatives to Hierarchies*. Leiden: Nijhoff, 1976.

Letvin, J. Y., et al. "What the Frog's Eye Tells the Frog's Brain." *Proceedings of the Institute for Radio Engineers* 47 (1959): 1940–51.

Luhmann, Niklas. "The Cognitive Program of Constructivism and a Reality That Remains Unknown." In *Selforganization: Portrait of a Scientific Revolution*, edited by Wolfgang Krohn, Gunter Kuppers, and Helga Nowotny. Dordrecht: Kluwer Academic, 1990.

Lyotard, Jean-François. *The Differend: Phrases in Dispute*. Translated by Georges Van Den Abbeele. Minneapolis: University of Minnesota Press, 1988.

Maturana, Humberto. "Science and Daily Life: The Ontology of Scientific Explanation." In *Research and Reflexivity*, edited by Frederick Steier. London: Sage, 1991.

Maturana, Humberto, and Francisco Varela. *Autopoiesis and Cognition: The Realization of the Living.* Dordrecht and Boston: D. Reidel, 1985.

———. *The Tree of Knowledge: The Biological Roots of Human Understanding.* Rev. ed. Translated by Robert Paolucci. Boston: Shambhala, 1992.

Popper, Karl L. *Conjectures and Refutations: The Growth of Scientific Knowledge.* 2d ed. New York: Basic Books, 1965.

Stepan, Nancy Leys. "Race and Gender: The Role of Analogy in Science." *Isis* 77 (1986): 261–77.

Varela, Francisco, Evan Thompson, and Eleanor Rosch. *The Embodied Mind: Cognitive Science and Human Understanding.* Cambridge: MIT Press, 1993.

von Foerster, Heinz. *Observing Systems.* Seaside, Calif.: Intersystems, 1981.

7. Making the Cut: The Interplay of Narrative and System, or What Systems Theory Can't See

N. Katherine Hayles

The originary moment for the creation of a system, according to Niklas Luhmann, comes when an observer makes a cut ("Cognitive Program"). Before the cut—before any cut—is made, only an undifferentiated complexity exists, impossible to comprehend in its noisy multifariousness. Imagine a child at the moment of birth, assaulted by a cacophony of noise, light, smells, and pressures, with few if any distinctions to guide her through this riot of information. The cut helps to tame the noise of the world by introducing a distinction, which can be understood in its elemental sense as a form, a boundary between inside and outside (Brown). What is inside is further divided and organized as other distinctions flow from this first distinction, exfoliating and expanding, distinction on distinction, until a full-fledged system is in place. What is outside is left behind, an undifferentiated unity. Other cuts can be made upon it, of course, generating other systems. But no matter how many cuts are made there will always be an excess, an area of undifferentiation that can be understood only as the other side of the cut, the outside of the form.

It is no accident that this story has a mythopoetic quality, for it is a mythology as much as a description. It is a way of explaining how systems come into existence that perform two tasks at once: it describes the generation of systems, and it also constructs the world as it appears from the viewpoint of systems theory. As the story indicates, the primary distinction necessary to be able to think systems theory is a cut that divides system from environment. According to systems theory's own account, however, there is also an outside to this cut, an area that from the viewpoint of systems theory can be seen only as a mass of undifferentiated world tissue. Another way to organize this material, I suggest, is narrative.

The coexistence of narrative with system can be seen in Luhmann's account of the creation of a system, for his account is, of course, itself a narrative. Its very presence suggests that systems theory needs narrative as a supplement, just as much, perhaps, as narrative needs at least an implicit system to generate itself. Narrative reveals what systems theory occludes; systems theory articulates what narrative struggles to see.

In constructing a narrative that will contest systems theory's account of how meaning is generated, I will follow Luhmann's advice. To get beyond the space enclosed by a system's assumptions, he recommends looking at ideas that, within the confines of a given system, can appear only as paradoxes or contradictions. One enlarges or escapes from a system, he believes, by interrogating what cannot be made logical, straight, or ordered within the system. As we know, his version of systems theory begins with an observer making a distinction. Where does this observer come from? Is he brought into view through the action of another observer looking at him? If so, where does this second observer come from? The problem is not solved by supposing that the observer observes himself, for then we must ask where this capacity to observe himself comes from. If we pose the question logically, as systems theory would have us do, it cannot be answered within the system, for it leads only to an infinite regress of observers, each of whom is constituted in turn by another observer.

Suppose we take another path and construct the question as a historical inquiry. From what intellectual predecessor, what preexisting body of discourse, does Luhmann draw in order to think of beginning with the observer? The answer to that question is clear, for Luhmann himself provides it. This way of thinking about systems comes from a modification of autopoiesis, a concept defined and developed by the noted Chilean neurophysiologist, Humberto Maturana. To get outside systems theory and interrogate what it cannot see, I will begin with a historical and narrative account of Maturana's work. More is at issue in this interrogation than Luhmann's construction of systems and Maturana's epistemology, influential as they are. I seek to understand the tension between narrative and systemic thinking in general. Why does Foucault, especially in his early work, have such difficulty accounting for epistemic shifts? Why does Lacan's account of psychological formations insist that women can find no way to represent themselves? Why does any system, once it is exposed by a systems theorist, tend to seem inescapable and coercive? To get a purchase on these questions, let us look at systems theory from the other side of the cut, that is, from narrative rather than the proliferating distinctions that constitute systems.

Cutting Away the World: Defining the Living as a Closed System

Maturana's epistemology is grounded in studies of perception. In the famous article "What the Frog's Eye Tells the Frog's Brain," Maturana and his coauthors demonstrated that a frog's visual system operates very differently from that of a human (Lettvin, Maturana, McCulloch, and Pitts). Small objects in fast, erratic motion elicit maximum response, while large, slow-moving objects evoke little or no response. It is easy to see how such perceptual equipment could be adaptive from a frog's point of view, because it allows him to perceive flies while ignoring other phenomena irrelevant to his interests. The results imply that the frog's perceptual system does not so much register reality as construct it. As the authors put it, their work "shows that the [frog's] 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 light upon the receptors" (1950). The work led Maturana to the maxim fundamental to his epistemology: "Everything said is said by an observer" (Maturana and Varela, *Autopoiesis and Cognition,* xxii).

Despite the potentially radical implications of the article's content, however, its form reinscribed the conventional realist assumptions of scientific discourse. Nowhere do the authors acknowledge that the reality they report is constructed by their sensory equipment no less than the frog's is by his. Faced with this inconsistency, Maturana had a choice. He could continue to work within the prevailing assumptions of scientific objectivity, or he could devise a new epistemology that would construct a picture of the world consistent with what he thought the experimental work showed. The break came with his work on color vision in primates, specifically humans. He and his coauthors found that that they could not map the visible world of color upon the activity of the nervous system (Maturana, Uribe, and Frenk). There was no one-to-one correlation between perception and the world. They could, however, correlate activity in a subject's retina with his color experience. If we think of sense receptors as constituting a boundary between outside and inside, this result implies that organizationally the retina matches up with the inside, not the outside. From this and other studies, Maturana concluded that perception is not fundamentally representational. As Maturana recounts in *Autopoiesis and Cognition,* he and his coauthors decided to treat "the activity of the nervous system as determined by the nervous system itself, and not by the external world; thus the external world would have only a triggering role in the release of the internally-determined activity of the nervous system" (xv).

Maturana's key insight was to realize that if the action of the nervous system is determined by its own organization, the result is necessarily a circular, self-reflexive dynamic. The organization of a system is constituted through the processes it engages in, and the processes it engages in are determined by its organization. To describe this circularity, he coined the term *autopoiesis,* or self-making. "It is the circularity of its organization that makes a living system a unit of interactions," he and Varela wrote in *Autopoiesis and Cognition,* "and it is this circularity that it must maintain in order to remain a living system and to retain its identity through different interactions" (9). He regarded the autopoietic closure of the space a system inhabits as the necessary and sufficient condition for it to be alive. Building on this premise of autopoietic closure, Maturana developed a new and startlingly different account of how we know the world.

Here let me pause for a digression. Before discussing Maturana's epistemology, I want to register an objection to the leap he makes when he goes from saying perception is nonrepresentational to claiming it has no connection with the external world. In my view, his data do not justify this larger claim. Other researchers, among them Walter Freeman and Christine Skarda, have also argued against a representational model of perception (Skarda). Freeman and Skarda's data on the olfactory perception of rabbits are akin to Maturana's results, in that the data indicate the rabbit's responses are transformative and highly nonlinear, influenced not only by the experience at hand but also by previous experiences the animal has had, his emotional state at the moment, and a host of other factors. To say the relation is transformative is different, however, from claiming there is no relation. The divorce of perception from external reality is at once the basis for the striking originality of Maturana's epistemology, and the Achilles heel that renders it vulnerable to cogent objections.

What is this epistemology? I will approach it in an anecdotal and narrative fashion, a rhetorical mode quite different from the highly abstract and reflexive language of *Autopoiesis and Cognition,* the landmark work Maturana coauthored with Francisco Varela. (Later I will have more to say about the mode of Maturana's exposition and the purposes his rhetorical formulations serve.) To enter Maturana's world, consider how the world would look from the point of view of one of your internal organs, say your liver. To imagine this fully, you will need to leave behind as much of your anthropomorphic orientation as possible. Your liver has no plans for the future or regrets about the past; for it, past and future do not exist. There is only the present and the ongoing processes in which it engages. Similarly, since your liver has no way to conjoin cause and effect,

causality does not exist for it. If you drink excessive amounts of alcohol, it may develop cirrhosis, for it is structurally coupled to its environment and its processes change in coordination with changes in the environment. This coupling does not, however, constitute causality. The causal link you discern between drinking and cirrhosis is constructed by you as an observer; your liver knows nothing of it.

Maturana's denial of causality is worth exploring in more depth. It is at once counterintuitive and central to his epistemology. Consistent with his premise of operational closure, he maintains that no information is exchanged between a system and its environment. Events that happen in the environment do not cause anything to occur in the living organism. Rather, they are the historical occasions for triggering actions determined by a system's organization. The difference between an event "triggering" an action and "causing" it may seem to be a quibble, but for Maturana, the distinction is crucial. Causality implies that information moves across the boundary separating an organism from its environment and that it makes something happen on the other side. Say you slap me and I become angry. In the conventional view, one would say that your slap caused me to be angry. As this inference indicates, a causal viewpoint organizes the world into subject and object, mover and moved, transmitter and receiver. The world of causality is also the world of domination and control. Maturana sought to undo this perception by positing that living systems are operationally closed with respect to information. A system acts always and only in accord with its organization. Thus events can trigger actions, but they cannot cause them because the nature and form of a system's actions are self-determined by its organization. For example, if I am a masochist, I may be pleased rather than angry at your slap. Your slap is only the historical occasion for the self-determined processes that I engage in as a result of being structurally coupled to my environment.

One implication of letting go of causality is that systems always behave as they should, which is to say, they always operate in accord with their structure, whatever that may be. In Maturana's world, my car always works. It is I as an observer who decides that my car is not working because it will not start. Such "punctuations," as Maturana calls them, belong to the "domain of the observer" (*Autopoiesis and Cognition* 55–56). Because they are extrinsic to the autopoietic processes, they are also extrinsic to the biological description that Maturana aims to give of life and cognition. To accommodate the difference in states between, say, a car that will and will not start, Maturana makes a sharp distinction between

structure and organization. Structure refers to the actual state of a system at a given moment. Structure changes over time as an organism grows, ages, contracts disease, recovers health. Organization, by contrast, defines the nature of the organism as such. Organization can be thought of as the complete repertoire of all the structures that the organism can exhibit and still remain that organism. When a system's organization changes, it ceases to be that kind of system and becomes something else, for example dead rather than alive. Always leery of reification, Maturana stressed that organization, as a concept, exists only in the domain of the observer. On the level of autopoietic process, it is not a concept but an instantiated reality implicit in the constitutive relations of the processes to each other.

It should be apparent by now that the cut Maturana makes between the observer and autopoietic process is intended to act as a prophylactic barrier against anthropomorphism. Our commonsense intuitions about the world are relegated to the "domain of the observer," leaving the space of autopoiesis free from contamination by time, causality, motivation, intentionality, and desire. Thus emptied, the autopoietic space feels surprisingly serene, in much the same way that Buddhist notions of emptiness are serene. (It is interesting in this regard that Varela, Maturana's coauthor, later connected his own version of embodied cognition with Buddhist philosophy [Varela, Rosch, and Thompson].) But serenity comes at a price. Autopoiesis, in the case of conscious organisms, must contain the observer, yet the observer, with his anthropomorphic projections and causal inferences, is precisely what has to be excluded for autopoiesis to come into view as such. The strain of these contradictory necessities can be seen in Maturana's construction of cognition. Clearly cognition must emerge from autopoietic processes if it is not to be treated as an ad hoc phenomenon, a soul injected into the machine. But what kind of cognition can autopoiesis produce? Because Maturana wants to eradicate anthropomorphic projections from his account of the living, the cognition that he sees bubbling up from autopoiesis is empty of representational content. It can thus scarcely qualify as conscious thought. At most it precedes or underlies the familiar lifeworld of representation that we occupy (or that occupies us).

The divorce of consciousness from autopoietic process results in a curious gap in the theory's circular reasoning. How do we know autopoietic processes exist? Recall that Maturana's epistemology is grounded in perceptual studies of the frog's visual system and primate color vision, among others. According to his epistemology, these studies (along with every other construction that presupposes time, causality, and represen-

tation) rely on concepts that are not intrinsic to autopoiesis but rather are punctuations introduced by observers. We know autopoietic processes exist because of these studies, but the epistemology of autopoiesis requires that these studies be regarded as "punctuations" extraneous and irrelevant to autopoiesis. The circularity that is one of the theory's strongest and most striking features is here interrupted by the cordon separating the observer from the processes that must nevertheless somehow give rise to her.

The quarantine of the observer also requires that Maturana ignore the feedback loops that connect the observer with her autopoietic processes. Suppose I have stalled my car on the railroad tracks and, as I struggle to get it started, I see a train speeding toward me. The future moment when the train will strike the car exists vividly in my imagination, and I have no difficulty foreseeing the causal chain of events that will splatter me and my car over the landscape. As a result of these punctuations, which according to Maturana exist only in my domain as an observer, my heartbeat accelerates, my respiration alters dramatically, and my endocrine system releases a flood of adrenaline into my body. Evidently, the observer is not only an observer but also an intrinsic part of the autopoietic totality. Why does this story, or its analogue, never get told in *Autopoiesis and Cognition*? To answer this question, I must take my narrative onto new ground and consider the rhetorical strategies that *Autopoiesis and Cognition* uses to construct its argument. How the story is told is also part of the story.

Self-Making as Literary Form: The Rhetoric of Autopoiesis

Aside from the introductions, *Autopoiesis and Cognition* consists of two essays, "Biology of Cognition" and "Autopoiesis: The Organization of the Living." In both essays, the writing is almost exclusively analytic, with one proposition related to another logically in an argument that proceeds by division and subdivision, implication and extension. There are only two examples of narrative, and they stand out because they are so unusual. In one, the authors illustrate the difference between an ordinary and an autopoietic viewpoint by supposing that two teams of builders are put to work constructing a house (53–55). The first team is told it is building a house, and each craftsman understands his work in that context. With the second team, no mention is made of a house. Rather, each craftsman is given a copy of a set of instructions and told which parts he is supposed to execute. In both instances the finished product is the same—the house is built. The first team thinks that it has been building a house all

along, however, whereas the second team thinks only that it has been en-gaging in a set of specified processes. The authors use the example to il-lustrate how a seemingly teleological project can emerge from processes that have no awareness of a larger goal. Although they do not interpret the example this way, it can also be used to illustrate why narrative is in tension with autopoiesis. The set of processes that the second team actu-ates could not be a story, or rather not a story anyone would find interest-ing, for lacking any sense of purpose, causality, or goal, it would consist only of a series of statements such as "This is happening, and then this is happening, and then something else is happening." To be effective, narra-tive requires a sense of how the present relates to past and future and of at least potentially causal relations between events.

The second anecdote is even more revealing. In it, the authors imagine that a man is piloting a plane by following his instrument readings (50–51). When he lands, his friends and family congratulate him on his excellent feat of navigation. He is amazed at their admiration, for from his point of view, he has only been manipulating the controls so that the dials on his instruments stay within specified limits. Repeated with slight variations several times in Maturana's writing (sometimes the pilot is in a plane, at other times in a submarine), this anecdote evidently has special meaning for him. Tyrone Cashman speculates on its significance in an imaginary dialogue he constructs between Maturana and Sartre. He imp-ishly has Sartre suggest that Maturana's epistemology, like Sartre's own views, were influenced by childhood experiences, particularly Maturana's poor eyesight. Sartre recalls a joke Maturana likes to tell on himself about being so nearsighted as a child that he could not tell the difference, until his brother pointed it out to him, between a stout lady waiting for a bus and a mailbox. Sartre says it is no wonder that Maturana makes a cut sepa-rating the observer from autopoietic processes, for what he observed as a child was indeed a punctuation different from what was there in reality. In Maturana's theory, Sartre observes, the world as we know it comes into existence when it is constructed by two observers "languaging" between themselves. Maturana's epistemology thus reinscribes the linguistic acts of distinction that took place when his brother told him that the heavyset woman was not, after all, a repository for mail. How would this episte-mology hold up, Sartre wonders, for "a rural child with sharp eyesight, who before the age of ten spent a great deal of time alone, by himself or herself, exploring woodlands and streams and lake shores, observing in-sects and the stages of plant life, stalking wild animals and listening to the subtle changes of bird calls—to such a person, your theory might sound

absurd. Languaging, for him or her, precisely inhibits good observation. When someone else is present, the natural world is perceived less vividly and richly" (Cashman 6–7).

This story, which we can consider a counternarrative to Maturana's anecdote about the pilot who flies blind, illustrates one of the dangers of narrative for someone who wants to construct a system. Unlike analytic writing, narrative is contextual. Instead of relying on numbered subdivisions to advance its plot, as Maturana's analytic writing does, narrative uses description. Inherent in the contextualization of narrative is a certain "loose bagginess" (as Henry James called it), for example, language necessary to set a scene or move the story from one locale to another. In Maturana's anecdote, there are phrases that put the man into the plane (or submarine) and take him out of it, even though these actions are not relevant to the story's point—relevant, that is, in his interpretation. As Cashman's send-up makes clear, what is extraneous and irrelevant in one reading can become highly relevant in another. Because narrative is contextual, it is polysemous in a way that analytic writing is not. Getting a narrative to mean only one thing is like getting a bowl of wiggling Jell-O to have only one shape. The medium won't allow it.

In addition to its contextuality, narrative differs from analytic writing in its use of historical contingency. When Maturana uses numbers to move from one statement to another, he is employing a semiotic system whose order is not in doubt, thus implying that the relation between his numbered statements is as definitive and noncontingent as the progression one, two, three. Narrative, by contrast, characteristically reinscribes historical contingency, relating events that might have happened other than they did. It was not inevitable that Maturana would be extremely nearsighted as a child and not wear corrective lenses; nor was it foreordained that Sartre as a child would be left alone to spend long days in the woods. Things just happened this way and (in Cashman's interpretation) later bore fruit in the two competing epistemologies. In contrast to these historical contingencies are the logical necessities that Maturana seeks to reveal through his analysis. Frequently, when he is obliged by custom or literary form to comment on his analytic writing (as in the introduction to *Autopoiesis and Cognition* or the "Comments" section of a journal article) he will express impatience, claiming that the piece is complete in itself and that to add anything further would be extraneous. These comments suggest that he regards his analytic writing as constituting a kind of closed autopoietic space in itself, secure in its circular organization and insulated against historical contingency. To bring that assertion

(or illusion) of closure into question, I turn now to an account of the historical contingencies that connect Maturana's theory to its predecessors in the Macy conferences.

Accidents of History: How Homeostasis Became Autopoiesis

As is often the case with heuristic examples, Maturana's anecdote about the navigator did not come out of nowhere. It had a predecessor in the Macy conferences. Funded by the Josiah Macy Foundation, the Macy conferences were annual affairs and ran for nearly a decade, from 1946 to 1953. Attendance was by invitation only. The idea was to bring together a group of researchers working at the forefront of their fields to forge a new interdisciplinary paradigm that became known, retrospectively, as cybernetics. Christened by Norbert Wiener, cybernetics was conceived as a science that would develop a common explanatory framework to talk about animals, machines, and humans by considering them as information processors that encoded and decoded messages, exacerbated or corrected their actions through feedback loops, and demonstrated circular causality. (See Heims for an account of the Macy conferences.)

A key concept in the Macy conferences was homeostasis. Understood as the ability of a system to maintain stability by keeping its parameters within certain limits, homeostasis was discussed in a context that made clear its relation to World War II. If homeostasis failed, W. Ross Ashby pointed out, the result was death, whereas if it succeeded, "your life would be safe" (von Foerster 79). Ashby illustrated the concept with an anecdote about an engineer in a submarine. The engineer avoids catastrophe by keeping the ship's parameters stable. As a biological organism, he is a homeostatic system in a feedback loop with the ship, which is also a homeostatic system; he keeps its homeostasis functioning, and as a result, he can maintain his own homeostasis as well. The example alludes to a situation that, in the context of the recent war, was resonant with danger; the man's vulnerable situation metonymically stood for the larger peril of a society drawn back from the brink of destruction. In the wake of the war homeostasis had a strongly positive valence, for it was the scientific counterpart to the "return to normalcy" that the larger society was fervently trying to accomplish.

To illustrate homeostasis, Ashby constructed an electrical device he called a homeostat that operated with transducers and variable resistors. When it received an input changing its state, the homeostat searched for the configuration of variables that would return it to its initial condition. In the postwar context, it seemed obvious that homeostatic calculations

must include the environment. If the environment is radically unstable, the individual organism cannot continue to survive. "Our question is how the organism is going to struggle with its environment," Ashby remarked, "and if that question is to be treated adequately, we must assume some specific environment (von Foerster 73–74). This specificity was expressed through the homeostat's four units, which could be arranged in various configurations to simulate organism-plus-environment. For example, one unit could be designated "organism" and the remaining three the "environment"; in another arrangement, three of the units might be the "organism," with the remaining one the "environment." Ashby arranged the mechanism so that if the homeostat did not compensate for environmental changes within specified limits, it overloaded or "died."

Elsewhere I have suggested that in the Macy conferences, homeostasis became the nucleus for a cluster of concepts that emphasized equilibrium and stability (Hayles). The homeostasis constellation developed in relation and opposition to another constellation centered on reflexivity. Through the idea of the feedback loop, homeostasis already had built into it the notion of circular causality. The man in the submarine, when he manipulates the dials, effects a change in some variable, say the air pressure in the control room. As a result, the oxygen level increases, and the man can think more clearly and operate the dials more efficiently. Thus the causal chain he initiated circles around to include his system as a biological organism as well. Applied to language, circular causality opened up a passage into the dangerous and convoluted territory of reflexivity, for it implied that an utterance is at once a statement about the outside world and a reflection of the person who uttered it.

It is significant that the word "reflexivity" does not occur in the Macy transcripts. Although the participants were struggling with ideas that, in contemporary usage, are commonly associated with reflexivity, the lack of a central term meant that the discussion was often diffuse, spreading out into diverse metaphors and discursive registers. The most intense debate about what I am calling reflexivity was embedded in a discourse that had its own assumptions, only one of which was reflexivity. This discourse was psychoanalysis. The conjunction between reflexivity and psychoanalysis was forged in the presentations made by Lawrence Kubie, a Freudian psychoanalyst associated with the Yale University Psychiatric Clinic. By all accounts, Kubie was a tendentious personality. Certainly his presentations evoked strong resistance from many participants, especially the physical scientists. As if to demonstrate circular causality, his repeated attempts to convince the scientists of the validity of psychoanalytic theory became

more intransigent as they met resistance, and they evoked more resistance as they became more intransigent. Kubie's central message was that language is always multiply encoded, revealing more than the speaker realizes. When some of the scientists objected to this idea, wondering what evidence supported it, Kubie in personal correspondence interpreted their resistance as hostility that itself required psychoanalytic interpretation. It is no wonder that the scientists were enraged, for in Kubie's hands, language became a tar baby that stuck to them the more they tried to push it away. The association of reflexivity with psychoanalysis meant, for many of the participants, that the concept was a dead end that had little or no scientific usefulness. Not only could it not be quantified, it also subverted normative assumptions about scientific objectivity.

The particularities of this situation—Kubie's halitosis of the personality, the embedding of reflexivity within psychoanalytic discourse, the unquantifiability of the concepts as Kubie presented them—put a spin on reflexivity that affected its subsequent development. The people at the Macy conferences who were convinced that reflexivity was a crucially important concept (including Margaret Mead, Gregory Bateson, and Heinz von Foerster) were marked by the objections it met within that context (see Brand for anecdotal evidence to this effect). The influence of these historical contingencies can be seen in von Foerster's treatment of reflexivity in *Observing Systems.* The punning title announces reflexivity as a central theme. "Observing" is what (human) systems do; in another sense, (human) systems themselves can be observed. The earliest essay in the collection, taken from a presentation given in 1960, shows that von Foerster was thinking about reflexivity as a kind of circular dynamic that could be used to solve the problem of solipsism. How does he know that other people exist, he asks? Because he experiences them in his imagination. His experience leads him to believe that they similarly experience him in their imaginations. "If I assume that I am the sole reality, it turns out that I am the imagination of somebody else, who in turn assumes that he is the sole reality" (7). In a circle of intersecting solipsisms, the subject uses his imagination to conceive of someone else, and then of the imagination of that person, in which he finds himself reflected; and so he is reassured not only of the other person's existence, but of his own as well. That even a fledgling philosopher could reduce this argument to shreds is perhaps beside the point. Von Foerster seems to recognize that it is the philosophical equivalent to pulling a rabbit from a hat, for he purports to "solve" the paradox by asserting what he was to prove, namely the existence of reality.

Although the argument is far from rigorous, it is interesting for the line of thought it suggests. Even more revealing is the cartoon (drawn at his request by Gordon Pask) of a man in a bowler hat, in whose head is pictured another man in a bowler hat, in whose head is yet another man in a bowler hat. The potentially infinite regress of men in bowler hats does more than create an image of the observer who observes himself by observing another. It also bears a striking resemblance to Maturana's phrase "domain of the observer," for it visually isolates the observer as a discrete system inside the larger system of the organism as a whole. The correspondence is not accidental. In the aftermath of the Macy conferences, one of the central problems with reflexivity was how to talk about it without falling into solipsism or resorting to psychoanalysis. The message from the Macy conferences was clear: if reflexivity was to be credible, it had to be insulated against subjectivity and presented in a context where it had at least the potential for rigorous (preferably mathematical) formulation. As Norbert Wiener was later to proclaim, "Cybernetics is mathematics or it is nothing" (Wiener).

Throughout the 1960s, von Foerster remained convinced of the importance of reflexivity and experimented with various ways to formulate it. A breakthrough occurred in 1969, when he invited Maturana to speak at a conference at the University of Illinois. Maturana used the occasion to unveil his theory of "cognition as a biological phenomenon" (*Autopoiesis and Cognition* xvi). The power of Maturana's theory must have deeply affected von Foerster, for his thinking about reflexivity takes a quantum leap up in complexity after this date. In his 1970 essay "Molecular Ethology: An Immodest Proposal for Semantic Clarification," he critiques behaviorism by making the characteristically reflexive move of turning the focus from the observation back onto the observer. Behaviorism does not demonstrate that animals are black boxes that give predictable outputs for given inputs, he argues. Rather, it shows the cleverness and power of the experimenter in getting them to behave as such. "Instead of searching for mechanisms in the environment that turn organisms into trivial machines, we have to find the mechanisms within the organisms that enable them to turn their environment into a trivial machine" (von Foerster 171).

By 1972, the influence of Maturana on von Foerster is unmistakable. In his 1972 essay "Notes on an Epistemology for Living Things," he casts Maturana's theory of autopoiesis into numbered quasi-mathematical propositions and gives it a circular structure, with the last proposition referring the reader back to the beginning (von Foerster). The influence was mutual, for von Foerster's idea that the observer is located in an

isolated arena became incorporated into Maturana's theory. Recall that von Foerster produced the observer through imagining an infinite regress of men in bowler hats; something of this ad hoc production lingers in Maturana's conception. If we ask where Maturana's observer comes from, it is apparent that he is not a biological production, which would imply a physiological explanation of how autopoiesis gives rise to consciousness. (The absence of such explanation is scarcely surprising, given that contemporary cognitive science lacked a detailed picture of how consciousness bubbles up from autopoietic processes.) Rather, the production of the observer is accomplished rhetorically, by positing an enclosed space called "the domain of the observer." Not coincidentally, the enclosure of the observer in this domain also creates a sanitized space where reflexivity can be acknowledged without rebounding back to ensnare the observer in every utterance he makes. In fact, just the opposite happens. The observations of the observer reflect back on himself but do not have efficacy in explaining autopoietic processes, which happen on their own in another sphere that is constructed to be objective precisely because it excludes the observer from its informationally closed space. Reflexivity is thus rehabilitated from the taint of subjectivity it received from its association with psychoanalysis in the Macy discussions, but at the cost of erecting a prophylactic barrier between the observer and autopoietic processes.

Here it may be useful for me to pause and reflect, in reflexive fashion, on the kind of argument I have been fashioning. Whereas the systems approach Maturana uses presents his theory as an autonomous entity sufficient in itself, the narrative approach I have been following shows how Maturana's theory both drew on and changed the concepts that preceded it. These changes did not happen gratuitously. At least in part, they were in response to particular historical contexts that had invested the constellations of homeostasis and reflexivity with specific interpretations, values, and problematics. What logic is to system, historical contingency is to narrative. Had Kubie had a different personality, or had von Foerster not constructed the observer in terms of solipsism, or had Maturana not been invited to the Chicago conference, the reflexivity constellation might have developed other than it did. While narrative may reach toward something approaching inevitability in seeing events as multiply determined, the kind of closure it evokes is qualitatively different from that which emerges from systems theory. The inevitabilities derive not from logical necessity but from contingency piled on contingency.

Also different are the continuities narrative traces between what came

before and what happened after. Whereas the systems approach treats systems as self-contained unities, the narrative approach sees systems coming into existence through patterns of overlapping replication and innovation. New ideas are woven not out of whole cloth (even cloth must have its predecessors in thread, loom, and pattern) but are forged out of previous instantiations and contexts that are partly changed and partly replicated. The term I appropriated (from archeological anthropology) to describe this pattern of overlapping replication and innovation is seriation. To see seriation in action, consider what happens to homeostasis as a concept evolving in specific historical contexts. As we have seen, for Ashby and his colleagues, homeostasis included the system plus the environment. Moreover, it used circular causality—that is, feedback loops between the system and environment—to return the system to equilibrium. The homeostat was an instantiation of a goal-seeking machine whose goal was stability. When it achieved stability, it was successful and "lived"; when it lurched into instability, it failed and "died." Considered essential for survival, homeostasis was thus linked to the idea of the living organism, although it included mechanical (and more speculatively, social) systems as well. In this respect, it carried out the imperative of the cybernetic program to create a common framework for animals, humans, and machines.

When Maturana took it over, he redefined homeostasis so that the circle of causality no longer went from the system to the environment but rather was contained internally within the autopoietic processes. At the same time, he manifested his allegiance to biology by leaving behind mechanical and social systems and making the closure of the autopoietic space the necessary and sufficient condition for a system to be living. He kept the idea of a goal, but now the goal was the continued production of the autopoietic space rather than stability. The goal of autopoiesis is more autopoiesis. Stability remained linked with survival, but the entities that were to be kept stable were redefined. No longer did survival demand that state variables had to remain within certain limits, as with homeostasis. Rather, the crucial entity that had to remain stable to ensure survival was organization. Instantiated within the autopoietic processes, a system's organization must persist unchanged through time for the system to retain its identity as such.

By showing seriation at work, I do not mean to imply that autopoiesis, as a theory, is defective or patched up. In fact, seriation usually works in the opposite direction of progressive refinement and fuller realization of the new elements that have entered the picture. Nor is it a reflection on

Maturana's originality to show that he appropriated ideas from models that preceded his. According to my argument, almost everyone does. Indeed, Maturana's theory is striking in its boldness and in its uncompromising vision of moving beyond anthropomorphic concepts of life. Although autopoiesis emerged from homeostasis, it is also substantially different from it, as I have indicated above. It actually represents a blending of ideas from both the homeostasis and reflexivity constellations. From homeostasis it appropriated stability, endurance, and survival; from reflexivity, the circular structure of a system turning back on itself to create a closed, self-referential space. It also explicitly rejects ideas that, in the Macy conferences, are associated both with reflexivity and homeostasis, for example circular causality (recall that for Maturana, causality does not exist in itself but only as a connection made in the domain of the observer).

The innovations that make autopoiesis different from homeostasis are clearly laid out by Paul Dell, a family systems theorist who has been at the forefront of the movement to apply autopoiesis to the field of family therapy. Dell points out several ways in which the language of homeostasis contains implications that are incompatible with autopoiesis. The one most relevant here, perhaps, is his argument that whereas homeostasis implies that a system will remain the same, autopoiesis implies a system will change. When Ashby designed the homeostat, he conceptualized it as a mechanism that searched for a function E-1 that compensates for a function E expressing complex change in the environment. As a result of this compensation, the machine's variables remain within specified limits. Its purpose, on this view, is to return the system back to an equilibrium whenever it is disturbed. From an autopoietic viewpoint, by contrast, the system is a system precisely in the sense that its components interact with each other; none can be separated out from the whole. Moreover, the system never reacts to changes in the environment, only to changes within itself triggered by its structural coupling with the environment. If one component changes—if, for example, the daughter of an alcoholic father ceases to facilitate his drinking—all of the other components have to change as well, because the interactions between them have changed. This reasoning implies that from an autopoietic viewpoint, change anywhere in the system drives the system toward a new configuration rather than back toward a prior equilibrium point.

Put this way, autopoiesis sounds as if it ought to be amenable to narrative progression, despite the self-circularity of its theoretical structure. The idea is put to the test in another book Maturana coauthored with

Varela. *The Tree of Knowledge* proposes to articulate autopoiesis together with the theory of evolution. Because the theory of evolution is about change and historical contingency, it is fundamentally narrative. I have been suggesting that systems theory and narrative constitute opposite approaches to the construction of meaning. What happens when systems theory meets evolution?

The Circle Versus the Line: A Disjointed Articulation

The circular structure of autopoiesis provides the inspiration for the literary form of *The Tree of Knowledge.* As the opening diagram of the chapters indicates, the authors envision each chapter leading into the next, with the final one coming back to the beginning. "We shall follow a rigorous conceptual itinerary," they announce in the introduction, "wherein every concept builds on preceding ones, until the whole is an indissociable network" (9). The structure is meant to enact their central idea that "all doing is knowing and all knowing is doing" (27) by showing the interrelation between simple and complex living systems. Accordingly, they start with unicellular organisms (first-order systems), progress to multicellular organisms with nervous systems (second-order systems), and finally to cognitively aware humans who interact through language (third-order systems). Humans are made up of cells, of course, so cellular mechanisms must be at work in complex systems as well; in this way, the end connects with the beginning. Autopoiesis, the continuing production of processes that produce themselves, is the governing idea connecting systems at all levels, from the single cell to the most complex thinking being. "What defines [living systems] is their autopoietic organization, and it is in this autopoietic organization that they become real and specify themselves at the same time" (48). Instantiating a linear narrative that turns into a circle, the book simulates an autopoietic structure in which the details produce the overall organization, and the organization produces the details. Traversing this path, the "doing" of the reader—the linear turning of pages as she reads—becomes also a kind of "knowing," for she experiences the structure of autopoiesis as well as comprehends it when the text circles back on itself.

The problem comes when the authors try to articulate this circular structure together with evolutionary "lineages"—literally, the creation of lines. In evolution, lineage carries both the sense of continuity (traced far enough back, all life originates in single-cell organisms) and qualitative change, as different lines branch off from one another and follow separate evolutionary pathways. Here I want to mark an important difference

between evolution and autopoiesis: whereas in autopoiesis lines become circles, in evolution lines proliferate into more lines as speciation takes place through such mechanisms as genetic diversity and differential rates of reproductive success. In an attempt to finesse this difference, Maturana and Varela proclaim repeatedly that for an organism to continue living, it must conserve autopoiesis as well as adaptation. And how does it do this? By remaining structurally coupled to its environment. As incremental changes occur in the environment, corresponding incremental changes also occur in the organism. Thus the organism always remains within the circle of autopoiesis, but this circular motion can also move along a line, as when a rolling ball falls downhill. "Ongoing structural change of living beings with conservation of their autopoiesis is occurring at every moment, continuously, in many ways at the same time. It is the throbbing of all life" (100).

The articulation of autopoiesis with evolution thus hinges on the claim that structures gradually evolve while still conserving autopoiesis. To describe the change that takes place, the authors use the term "natural drift." There seems to be a natural drift in "natural drift," however, and in later passages it becomes "structural drift." If structure changes, what does it mean to say that autopoiesis is conserved? Here they fall back on the distinction between structure and organization they had previously used in *Autopoiesis and Cognition*: "Organization denotes those relations that must exist among the components of a system for it to be a member of a specific class. Structure denotes the components and relations that actually constitute a particular unity and make its organization real" (47). Interestingly, they use a mechanical rather than a biological analogy to illustrate the distinction. A toilet's parts can be made of wood or plastic; these different materials correspond to differences in structure. Regardless of the material used, however, it will still be a toilet if it has a toilet's organization (47). The analogy is strangely inappropriate for biology. For life forms based on protein replication, it is not the material that changes but the way the material is organized.

What does it mean, then, to claim that autopoiesis is conserved? According to them, it means that organization is conserved. And what is organization? "Those relations that must exist among the components of a system for it to be a member of a specific class" (47). These definitions force one to choose between two horns of a dilemma. Consider the case of an amoeba and a human. Either an amoeba and a human have the same organization, which would make them members of the same class, in which case evolutionary lineages disappear because every living system

has the same organization; or else an amoeba and a human have different organizations, in which case organization—and hence autopoiesis— must not have been conserved somewhere (or many places) along the line. The dilemma reveals the tension between the conservative circulari- ty of autopoiesis and the linear thrust of evolution. Either organization is conserved and evolutionary change is effaced, or organization changes and autopoiesis is effaced. Contrary to the authors' assertions, the circle cannot be seamlessly articulated with the line. Whatever recuperations the authors attempt through their title, the tree Darwin used to image descent has a branching structure that remains at odds with the circu- larity of autopoiesis.

The strain of trying to articulate autopoiesis with evolution is most apparent, perhaps, in what is not said. Genetics is scarcely mentioned, and then in contexts that underplay its importance. At one point, the au- thors acknowledge that "modern studies in genetics have centered main- ly on the genetics of nuclear acids," but they suggest that other heredity systems have been obscured by this emphasis, including "those associated with other cellular components such as mitochondria and membranes" (69). Elsewhere they acknowledge that they have "skimmed over" popu- lations genetics but claim that "it is not necessary to scrutinize the under- lying mechanisms" (i.e., genetics) to understand "the basic features of the phenomenon of historical transformation of living beings" (115). In the absence of any discussion of genetics, how do they explain evolutionary change? Through an organism's structural coupling with the environ- ment, combined with the structural diversity introduced by [sexual] re- production. One is left with the impression that the primary mechanism of evolution is structural change within an organism due to its inter- actions with its environment, which are passed on to its offspring. "To sum up: evolution is a natural drift, a product of the conservation of autopoiesis and adaptation" (117). Thus they concur with Lamarck and Darwin, placing themselves outside the synthesis between evolution and genetics that produced contemporary evolutionary biology.

Given their emphasis on autopoiesis, it is perhaps obvious why they choose to sidestep genetics, for any discussion of genetics would immedi- ately make clear that the distinction between structure and organization cannot be absolute–and if this distinction goes, then autopoiesis is no longer conserved in evolutionary processes. For if organization is con- strued to mean the biological classes characterized as species, then it is apparent that organization changes as speciation takes place. If organiza- tion means something other than species, then it ceases to distinguish

between different kinds of species and simply becomes instead the property of any living system. Conserving organization means conserving life, which may be adequate for autopoiesis to qualify as a property of living systems but does nothing to articulate autopoiesis with evolutionary change.

The essential problem here is not primarily one of definitions, although it becomes manifest at these sites in the text because they are used to anchor the argument, which otherwise drifts off into such nebulous terms as "natural drift." Rather, the difficulties arise because of Maturana's passionate desire to have something conserved in the midst of continuous and often dramatic change. Leaving aside the hand-waving explanations of structure and organization, that something is basically the integrity of a self-contained, self-perpetuating system that is operationally closed to its environment. In Maturana's metaphysics, the system closes on itself and leaves historical contingency on the outside. Even when he is concerned with the linear branching structures of evolution, he turns this linearity into a circle and tries to invest it with a sense of inevitability. Narrative is encapsulated within system, like a fly within amber. Seen as a textual technology, *The Tree of Knowledge* is an engine of knowledge production that vaporizes contingency by continuously circulating within the space of its interlocking assumptions.

Like many postwar systems, including Foucault's epistemes and Lacan's psycholinguistics, autopoiesis is profoundly subversive of individual agency. It therefore makes an interesting comparison with Richard Dawkins's idea of the "selfish gene," another theory that locates the essence of life in aconscious processes rather than conscious subjectivity. Whereas Maturana elides genetics, Dawkins foregrounds it. This difference reflects a deeper divergence in their treatments of agency. Dawkins images humans as "lumbering robots" controlled by their genes, but agency is not missing from his scheme; it is simply displaced from the conscious mind into the genes. The social and economic formations associated with rampant individualism, especially capitalism, are as vigorous as ever in Dawkins's rhetoric and narratives. The players may have shrunk to microscopic size, but the rules of the game—and the stakes it entails—remain the same. Maturana, by contrast, constructs agency as a contest over how the boundaries are drawn that constitute systems. Complex systems are made up of parts that are themselves autopoietic entities. Thus a human is constituted through its cells, which in turn are made up of yet smaller entities. Which of these autopoietic systems is subordinate to which? The answer, for Maturana, is not so much a given

as an ethical imperative that depends on prior assumptions about free-
dom and what he unashamedly calls love. In an organism, the compo-
nent unities are properly subordinated to the organismic whole. The case
is different for a society. There, the system exists for the benefit of its
component parts, namely individual humans. For Maturana, autopoiesis
resides finally and most forcefully at the level of the individual.

Other than as an ethical imperative, why this should be so remains
shrouded in mystery. Because past and future do not exist in Maturana's
scheme except as modes of existing in the present, it is not possible to
ground this imperative in a myth of origin. "The business of living keeps
no records concerning origins," he and Varela write in *The Tree of Knowl-
edge.* "All we can do is generate explanations, through language, that re-
veal the mechanism of bringing forth a world. By existing, we generate
cognitive 'blind spots' that can be cleared only through generating new
blind spots in another domain. We do not see what we do not see, and
what we do not see does not exist" (242). One of these cognitive blind
spots, I have been arguing, is narrative. And one of the windows that
opens onto it, I have further suggested, is the construction of the observer
in systems theory. When Niklas Luhmann makes the move of turning
the construction of the observer into an origin, he departs from the circu-
larity of autopoiesis and begins a new cycle in the seriated pattern of over-
lapping innovation and replication that lies at the heart of my narrative.

The Observer as Origin: Luhmann's Reinscription of Maturana

When Luhmann begins with the observer, in a stroke he does away with
the difficulties Maturana encountered by rhetorically constituting the
observer within a separate "domain" isolated from the autopoietic system
("Cognitive Program"; *Essays on Self-Reference*). Far from being impris-
oned within the system and existing in an ad hoc relation to it, the ob-
server now generates the system by drawing a distinction. The reflexivity
that appeared so threatening within the context of the Macy conferences,
after being sanitized and encapsulated in an isolated domain, thus reenters
the system at a foundational moment.

Perhaps Luhmann felt free to make this move because he is primarily
concerned with social theory rather than biology. As a social theorist, he
obviously does not have the same stake as Maturana in avoiding anthro-
pomorphic projections of what life is.

Just as Maturana redescribed terms and shifted emphases when he in-
scribed into biology ideas appropriated from cybernetics, so Luhmann
changes as well as reinscribes autopoiesis when he takes it into social

theory. Insofar as Maturana succeeds in linking autopoiesis with life, he wins for it a central position within biology, for it addresses a concern fundamental to the discipline. When Luhmann applies autopoiesis to social systems, he is led by this history to say that social systems are alive. But in importing the claim into a different disciplinary context, he also changes its position. Whereas for Maturana the connection with life is crucial, in Luhmann the claim that social systems are alive does no interesting work within his theory and, indeed, is scarcely developed beyond this bare assertion. It rather exists as a skeuomorph, that is, a feature that served an instrumental purpose in previous instantiations but now works as an allusion and a link to the past. The fabric of seriation is woven out of skeuomorphs as much as innovations.

The pattern of seriation can also be seen in Luhmann's appropriation of other ideas central to autopoiesis. Consider Maturana's postulate that autopoietic systems are informationally closed and that they always conserve their organization. In Luhmann these ideas are transformed into his premise that social systems are operationally closed (*Differentiation of Society*; "Operational Closure"). The difference between operational and informational closure is revealing. Recall that for Maturana, the idea of closure was grounded in his studies of perception. For Luhmann perception is more or less beside the point, since he is dealing with societies rather than organisms. Accordingly, the mechanism of closure is displaced from the working of perception onto the working of codes. One system cannot communicate with another because they employ different codes; the operations that a system can perform are defined and contained by the codes it employs. The circularity of autopoiesis is thus realized for Luhmann in the interplay between a system's codes and its organization. The operations it performs through its codes define its organization, and its organization defines the codes. In Maturana, the essence of life is displaced from (human) consciousness onto aconscious autopoietic processes. In Luhmann, this displacement is registered as the play of codes within a system. Luhmann does not see social interactions as exchanges between purposeful individuals with complex psychologies. Rather, interaction takes place between the codes that social agents employ. It is the codes, not the agent's conscious thoughts or perceptions, that structure the situation. When one goes out to drink, one employs the code of drinking, and it is this code, not the individual's thoughts or activities, that constitute drinking as drinking. What autopoietic biological processes are to Maturana, social codes are to Luhmann.

We saw earlier that Maturana constructed agency in terms of where

a system's boundaries are drawn. From societies to organisms to cells, systems are complex unities that themselves are composed of systems that are complex unities. The question of which level can or should subordinate the other levels to itself is for Maturana an ethical issue that cannot be decided within systems theory. There is nothing inherent in the nature of systems that dictates the organism should dominate its subsystems, whereas a society should be subordinate to its subsystems. Maturana recognizes the fragility of this argument when he identifies it with love. In a theory remarkable for the circularity of its interlocking premises, love enters as excess, emerging not from necessity but desire. A similar dynamic is played out in Luhmann's work in his idea of a functionally differentiated society. Whereas in medieval times societies were organized vertically, with each subsystem subordinate to the larger system that contained it, in the modern period some societies have achieved a horizontal structure that enables different subsystems to operate independently of one another. This is the kind of structure that Luhmann prefers, for he believes it fosters diversity and minimizes coercion. But he recognizes that there is nothing inevitable about its emergence. Indeed, he regards it as sufficiently improbable so that it is at any time liable to collapse and revert back to a hierarchical structure, as happened in Nazi Germany. Thus the fragility of love and the vulnerability of desire is replicated as well as changed in Luhmann's reinscription of autopoiesis.

Of all these seriated relationships, perhaps the most crucial is the one with which we began: the point at which the observer is inserted into the system. By moving the observer to the point of entry or origin, Luhmann opens the system—any system—to alternative constructions. As a result, although his systems are no less closed than Maturana's, the activity of system making is considerably more open. The difference is registered in the phrase that Luhmann adapts from Maturana's dictum "we do not see what we do not see." In a reinscription that is also an innovation, Luhmann writes that "reality is what one does not perceive when one perceives it" ("Cognitive Program" 76). Like Maturana, Luhmann postulates a realm that remains apart from the constructed world of human perception. But unlike Maturana, he twists the closed circle of tautological repetition ("we do not see what we do not see") into an asymmetric figure ("one does not perceive when one perceives"). The energy generated by these contradictory propositions rebounds like a loaded spring toward the very term that Maturana's closure was designed to erase, namely "reality." What is enacted rhetorically within the structure of this sentence is formalized in Luhmann's theory by investing the observer with the

agency to draw a distinction. By making a distinction, the observer reduces the unfathomable complexity of undifferentiated reality into something she can understand; by proliferating distinction on distinction, she begins to reproduce within this space of differentiation some of the complexity and diversity of a reality that remains forever outside (*Differentiation of Society*, "Operational Closure").

The importance of Luhmann's positioning of the observer has been recognized in different ways by a number of theorists writing in this volume. William Rasch concentrates on the siren call of the transcendent, which he sees Luhmann, along with his predecessor Wittgenstein, successfully resisting; Jonathan Elmer notes parallels between Luhmann's theory and Lacan's construction of the observer in the mirror stage; Cary Wolfe argues persuasively that Luhmann's importance for this cultural moment lies in the alternative he offers to the seemingly endless quarrels between constructivists and realists. My argument seeks to position itself at the very point where the observer comes into view at all. When Luhmann acknowledges that the observer, by drawing a different distinction, can generate a different kind of system, he opens a trapdoor out of the coerciveness of systems. But this is a limited kind of escape, for in Luhmann's metaphysics, escape from one system is achieved only by entering another system. My efforts have been directed toward providing an alternative—not another system, but another way of organizing the material that is narrative rather than systemic.

To recapitulate: the advantage I claim for narrative is that it renders the closures that systems theory would perform contingent rather than inevitable, thus mitigating the coercive effects that systems theory can sometimes generate. As I see it, the problem with systems theory is that once a system stands revealed in all its pervasiveness and complexity—whether it be the invisible workings of power in Foucault's society of surveillance, or Lacan's psycholinguistics, or Maturana's autopoiesis—the system, precisely because of its logic and power, is likely to seem inevitable and inescapable. Among systems theorists, Luhmann is remarkable in seeing that every system has an outside that cannot be grasped from inside the system. If his own inclination is toward the closure of system rather than the contingency of narrative, he nevertheless has the intellectual honesty and generosity of spirit to see that closure, too, has an outside it cannot see. And this has given me room to argue that the very interlocking assumptions used to achieve closure are themselves the result of historical contingencies and embedded contextualities. Thus in my reading, a system looms not as an inevitability, but rather emerges as

a historically specific construction that always could have been other than what it is, had the accidents of history been other than what they were. In this reading, one exits the system not merely to enter another system, but to explore the exhilarating and chaotic space of constructions that are contingent on time and place, dependent on specific women and men making situated decisions, partly building on what has gone before and partly reaching out toward the new.

Works Cited

Brand, Stewart. "'For God's Sake, Margaret': Conversation with Gregory Bateson and Margaret Mead." *The CoEvolution Quarterly* (summer 1976): 32–44.

Brown, George Spencer. *Laws of Form.* New York: Julian Press, 1972.

Cashman, Tyrone. "The Elysian Dialogs." *A Newsletter of Ideas in Cybernetics* 17 (summer 1989): 1–9.

Dawkins, Richard. *The Selfish Gene.* Oxford: Oxford University Press, 1976.

Dell, Paul F. "Beyond Homeostasis: Toward a Concept of Coherence." *Family Process* 21 (March 1982): 21–44.

Hayles, N. Katherine. "Boundary Work: Homeostasis, Reflexivity, and the Foundations of Cybernetics." *Configurations* 2 (fall 1994): 441–68.

Heims, Steve J. *The Cybernetics Group.* Cambridge: MIT Press, 1991.

Lettvin, J. Y., H. R. Maturana, W. S. McCulloch, and W. H. Pitts. "What the Frog's Eye Tells the Frog's Brain." *Proceedings of the Institute for Radio Engineers* 47 (1959): 1940–51.

Luhmann, Niklas. "The Cognitive Program of Constructivism and a Reality That Remains Unknown." In *Selforganization: Portrait of a Scientific Revolution*, edited by Wolfgang Krohn, Gunter Kuppers, and Helga Nowotny. Dordrecht: Kluwer, 1990.

———. *The Differentiation of Society.* New York: Columbia University Press, 1982.

———. *Essays on Self-Reference.* New York: Columbia University Press, 1990.

———. "Operational Closure and Structural Coupling: The Differentiation of the Legal System." 13 *Cardozo Law Review* 1419 (1992).

Maturana, Humberto R., G. Uribe, and S. Frenk. "A Biological Theory of Relativistic Color Coding in the Primate Retina." In *Archivos de Biología y Medicina Experimentales.* Suplemento 1. Santiago, Chile: 1968.

Maturana, Humberto R., and Francisco J. Varela. *Autopoiesis and Cognition: The Realization of the Living.* Dordrecht and Boston: D. Reidel, 1980.

————. *The Tree of Knowledge: The Biological Roots of Human Understanding.*
    Boston and London: New Science Library, 1987.
Skarda, Christine A. "Understanding Perception: Self-Organizing Neural
    Dynamics." *La Nuova Critica* 9–10 (1989): 49–60.
Varela, Francisco J., Eleanor Rosch, and Evan Thompson. *The Embodied Mind:
    Cognitive Science and Human Experience.* Cambridge: MIT Press, 1991.
von Foerster, Heinz. *Observing Systems.* Seaside, Calif.: Intersystems, 1981.
————, ed. *Cybernetics: Transactions of the Ninth Conference.* New York: The
    Josiah Macy Jr. Foundation, 1953.
Wiener, Norbert. *God and Golem, Inc.: A Comment on Certain Points Where
    Cybernetics Impinges on Religion.* Cambridge: MIT Press, 1964.