Why We Cannot Know Complex Things Completely

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Paul Cilliers

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Despite wonderful advances in the mathematics and science of complexity, despite clever modeling techniques, despite fantastic computing machines, and, above all, despite its being somewhat fashionable, I wish to argue that complexity theory will not lead to a grand science that will solve many of those difficult outstanding problems of science and philosophy. Rather, I wish to argue that the study of the characteristics of complex dynamic systems is showing us exactly why limited knowledge is unavoidable—or, to be more precise, why knowledge *has to be* limited. The study of complexity, in other words, is not going to introduce us to a brave new world in which we will be able to control our destiny; it confronts us with the limits of human understanding. (This position is, to my mind, supported by the large-scale problems experienced in the so-called new economy, especially in the context of the disappointing performance of so many overpromoted software companies.)

Before this position is elaborated, it should be made clear what is not being claimed. In the first place, the argument has nothing to do with the dispute about the so-called end of science; see among others Durlauf (1997), Horgan (1996), and Lindley (1993). No claim is made that we have already discovered most of the fundamental scientific theories, and that new science will only be derivative. This is a hubristic position that glorifies the present. Nor is a claim made that fundamental advances will not be made in those sciences (like the human sciences) normally perceived as too complex, or where empirical results have so far been disappointing. This is a defeatist position, often triggered by an overevaluation of socalled hard scientific results or methods. There is no reason not to believe that there is much to be learned. The argument is just that, as far as complex systems are concerned, our knowledge will always be contextually and historically framed.

It is also not claimed that there is something wrong with modeling complex systems. Computational and mathematical models of different kinds are doing wonderful things, and new avenues should be pursued all the time. However, we should be careful about the claims made about the "knowledge" we gain from many of these models. The models are often as complex as that being modeled, and thus do not always lead to deeper understanding of the systems at stake. In order to gain "knowledge" from complex models they have to be interpreted, and these interpretations will always involve a reduction in complexity. Thus the main argument is not that there is something metaphysically unknowable about complex systems, but rather that we cannot "know" a system in all its complexity despite the fact that we may be able to model its behavior on a computer. (This allowance that good models of complex systems may exist is a generous one. Most models of complex systems are used to display general complex behavior, not to model specific, empirical complex systems. This state of affairs may remain so, again not for metaphysical reasons, but because the behavior of complex models will be as unpredictable as that of the systems they model.) We are returned to the old philosophical problem concerning the relationship between our descriptions of the world and the world itself.

ONTOLOGY VS. EPISTEMOLOGY

The traditional way of dealing with this problem is to distinguish between epistemological and ontological issues. Epistemology has to do with the way in which we understand and describe the world, and ontology with the way the world is. One can therefore talk of epistemological complexity (how complex are our descriptions?) and ontological complexity (how complex are things really in themselves?). Using this distinction, one could deal with the problem of our knowledge of the world in the following way: The world itself is not complex, it just is. There is nothing mystical about complex systems. It is merely that we cannot keep track of all the millions of nonlinear interactions when we have to describe it. Complexity is therefore only an epistemological matter. This is how McIntyre (1998: 28) describes this position:

> *[Complex systems, like human systems] are not complex "as such" but only complex as described and defined by a given level of inquiry. What is the nature of our interest in human behaviour? What sort of questions do we ask about it? That is what will determine the level of complexity that we are dealing with when we seek to understand certain features of human interaction. For the subject matter of social science is not a "natural kind" just sitting out there waiting for us to discover it. A subject matter is created only when we begin to ask questions about features of reality that are puzzling us. Thus, on this interpretation, complexity is derivative rather than inherent.*

This argument has the advantage that it demystifies complexity somewhat. For example, we do not have to let go of causality in order to acknowledge complexity. The world is not dependent on our descriptions. McIntyre (1998: 28), however, uses the ontological/epistemological distinction to make another point, namely that this would mean "that there is no 'fundamental' limit to our understanding of 'complex' systems."

> *Once one accepts that complex systems are only complex "as described," there is always the possibility that some alternative description—some "redescription"—of the system will yield regularities that will be simpler and can be handled by science … The job of science, then, is to search for those descriptions of the phenomena that will unlock the regularities that are behind the surface noise of complexity. (McIntyre, 1998: 29)*

This argument is in general a useful one, but on certain points somewhat problematic. At heart it is an instrumentalist position, made explicit by the claim that "in attempting to understand reality, we have many descriptive tools at our disposal … There may be one world, but there are an infinite number of alternative ways of describing it" (McIntyre, 1998: 29). Despite his attempts to deny it ("nature rules out infinitely many descriptions that are inconsistent with it"), this position will have serious difficulties in defending itself against the accusation of relativism.

These difficulties are the result, I would argue, of a too simplified, or perhaps even contradictory, understanding of the relationship between our description of the world and the world itself. On the one hand McIntyre (1998: 28) separates the two quite clearly, accusing others (e.g., Hayek) of failing to distinguish "sharply" between ontology and epistemology, but at the same time it wants to affirm that science is about reality. This is to have your cake and eat it. In the end such a sharp distinction between epistemological and ontological issues cannot be maintained. Even if we acknowledge that our descriptions of the world are not perfect, we would like to maintain that they are not merely instruments, but that they enhance our knowledge of the world as it is. There is a complex dialectical relationship between the world and our descriptions. When we try to understand the world we are always dealing with ontological and epistemological issues simultaneously. To maintain a clear distinction between the two is the essence of metaphysics.

WHAT IS KNOWLEDGE?

If it is argued that epistemology and ontology cannot be kept apart systematically, what becomes of the notion of "knowledge"? This is one of the words that have become commodified in our times. We talk of a "knowledge industry" and of "knowledge management." These terms create the impression that knowledge is something in which we can trade, independently of the subject that has the knowledge. In this way knowledge is reified, turned into something that "exists," that can be put on a disk or a website. Of course, there are many things we can put on a disk, but perhaps one should reserve the terms "data" or even "information" for this. The term "knowledge," I suggest, should be reserved for information that is situated historically and contextually by a knowing subject. Knowledge is that which has meaning, it is the result of a process of interpretation (see also Cilliers, 2000).

There is nothing new about linking knowledge and the knowing subject. It may also appear as if it reinstates an independent epistemological level. However, from the perspective of complexity theory, these issues look a little different. In the first place, the subject is not an independent whole, not a free-floating ego that makes "subjective" observations or decisions. It is a complex thing in itself, constituted through the web of relationships with others and the world. The subject itself can therefore only be understood as something contextualized through and through (see Cilliers & De Villiers, 2000).

Secondly, complexity theory also helps us to understand the process by which things and concepts acquire meaning differently. I argue in detail elsewhere (Cilliers, 1998: 58-88) that we cannot maintain a representational theory of meaning. Meaning is not something complete and abstract, linked to the sign that represents it, but is the result of a dynamic interaction between all the meaningful components in the system (Cilliers, 1998: 37-47), itself a complex process.

If meaning is relational, not representational, there are potentially an infinite amount of relationships at stake each time the meaning of something is generated. Complex systems are open systems; interactions take place across their boundaries. However, if an infinite number of interactions have to be considered, the production of meaning will be indefinitely postponed. This, we know, is not the case. Meaning is generated in real time. How is this possible? Because meaning is constituted in a specific context where some components are included and others not. It would not be possible to have any real meaning if the number of relationships were not limited. In other words, for meaning or knowledge to exist at all, there have to be limits. We cannot comprehend the world in all its complexity. We have to reduce that complexity in order to generate understanding. This is not some terrible fate that befell human subjects, it is merely the result of having to deal with the world in real time with finite means.

To summarize: We are simultaneously in the world and reflecting on the world. These processes are intertwined and involve the interaction of an infinite number of factors. The knowing subject is, however, contextualized. The context limits the number of factors, and thereby makes meaning possible. The context can change, of course, and thereby involve other factors. However, the new context will involve new limits. We cannot have knowledge without limits. An interesting question that I will not pursue here is whether we can have knowledge of emergent properties. Perhaps the answer is no!

LIMITS AND BOUNDARIES

Talking about the limits or boundaries of complex systems is not an easy task. On the one hand we acknowledge that complex

systems are open, that they exchange information (or matter and energy) with their environment. This would tend to underplay the role of the boundary. On the other hand, the very notion of “system” presupposes the existence of a boundary to the system. For the system to be identified as such it has to be distinguished from what is not part of the system, that is, the environment or other systems. Both positions can be problematic.

One can, and often should, emphasize the interrelatedness of systems. Often the boundaries of systems are constructions that we impose in order to reduce the complexity. This can lead to oversimplifications, to reductive descriptions of the system. However, if boundaries become too vague, we end up with a kind of holism that does not allow much to be said. We cannot consider life, the universe, and everything in its totality all the time. We need limits in order to say something.

One can, nevertheless, also overemphasize the role played by the boundaries of a system. To my mind, this is the case with Luhmann’s position in his elaboration of Maturana and Varela’s arguments concerning autopoiesis (for an excellent discussion of these positions, see Rasch, 2000). The claim that a system can only make representations in terms of its own resources results in what Luhmann calls “operational closure.” Thus the legal system, for example, can only operate in legal terms. It organizes legal procedures, so there is change in the system, but this change is always in terms of evolutionary processes taking place within the system. This position makes it difficult to see how any intervention in the dynamics of the system can take place. The claim for operational closure leads to a self-sufficient conceptualization of the system. Since the “knowledge” contained within the system has to be constructed in terms of the internal resources of the system, it is again difficult to see how this position can escape the charge of relativism.

Perhaps one can evade some of these complexities by making a distinction between boundaries and limits. Since this distinction attempts to reduce complexity, it will, like most distinctions, come under pressure in certain contexts. However, it also allows us to say new things about complex systems. The suggestion is that a boundary is something with two sides, like the boundary of a country. A limit, on the other hand, we can only know from one side, that is, we cannot know what is beyond it. Let us examine the two concepts briefly.

The notion of a boundary seems fairly clear cut. It refers to that which contains and constrains a system. The skin is the boundary of the body; a dam ends where the water ends. However, more often than not it is extremely difficult to determine where exactly the boundary is. Think, for example, of the boundary as those elements of a system that interact directly with the environment of the system. If one conceives of a complex system as something constituted through a rich interaction of all its components, there is only a short route between any element and the environment. In a sense, the whole system is close to the boundary, the boundary is “folded in,” and one is never quite sure whether one is dealing with the inside or the outside of the system. The boundary is there, but one cannot pin it down.

At the same time, one should also not think of the boundary as something confining the system, but rather as something that constitutes the system. By differentiating the system from the environment, and simultaneously allowing for the transcending of the boundary, the system can be and become what it is. A good example to illustrate this principle is that of the eardrum. It separates the inner and outer ear, but exists in order to let sound come through. Moreover, it would not have been possible for the sound to come through if the boundary were not there. (See Cilliers, 2001, for a further discussion of boundaries. There the distinction between limits and boundaries is not made explicit.)

The notion of the limit is a difficult one (and needs a more detailed discussion than will be attempted here). For example, if we concede that there are limits to our knowledge, how do we know when we have reached that limit? It is exactly this claim—that we have reached the limit and that we know it—that leads to the “end of science” argument. Furthermore, how do we talk about limits if we do not know what lies beyond? Do we maintain a Wittgensteinian silence, or do we make assumptions about what lies beyond—a move that will return us to the traditional world of metaphysics?

Perhaps complexity theory can help us deal with this problem in somewhat different terms. Without falling back into a crude dichotomy between epistemology and ontology, we could argue that the world itself does not have limits, only boundaries. Limits exist in our understanding and descriptions of the world (keeping in mind that these descriptions are not arbitrary constructions, but that they are constrained by reality, that they are “about” the world). The limits are not transcendentally given, but a result of having to deal with complexity with finite means. If this is the case, then there is no reason that the limits cannot be shifted. There will always be limits, thus there will always be something that eludes our understanding of a complex system, but from different perspectives, following different strategies, these limits will be different. To keep on confronting these limits is what science—and life—is all about. Nevertheless, they will remain limits in the sense that we cannot say what it is that eludes us. We cannot calculate what it is that escapes our grasp.

What we need, therefore, are ways of dealing with that which we cannot calculate, of coping with our ignorance. There is a name for this. It is called “ethics,” and no amount of complexity theory will allow us to escape it.

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