Emergence, Materialism, and Worldviews: A Review Article

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ABSTRACT Key Words: chaos theory; complexity; emergence; Intelligent Design; materialism; Polanyi, Michael; reductionism; self-organization
This review article deals with four recent books exploring issues of emergence and self-organization. Three of these also deal with issues of materialism and religious worldviews, while one charts the history and philosophical unerpinnings of emergentist thought.

Stephen M. Barr, *Modern Physics and Ancient Faith*. Notre Dame, Indiana: University of Notre Dame, 2003. Pp. ix + 312. ISBN 0-268-03471-0. $30.00, hardcover.

Richard J. Bird, *Chaos and Life: Complexity and Order in Evolution and Thought*. New York: Columbia University Press, 2003. Pp. x + 322. ISBN 0-231-12662-x. £20.50, $29.50, hardcover.

Kees van Kooten Niekerk and Hans Buhl (eds.), *The Significance of Complexity: Approaching a Complex World Through Science, Theology and the Humanities*. Aldershot: Ashgate, 2004. Pp. xi + 243. ISBN 0-7546-0972-3. £50.00, $89.95, hardcover.

Achim Stephan, *Emergenz: Von der Unvorhersagbarkeit zur Selbstorganisation*. (Emergence: from unpredictability to self-organization.) Dresden/München: Dresden University Press, 1999. Pp xiv + 292. ISBN 3-933168-09-0. •44.99, paperback (sold out). *2nd. Ed.*, Paderborn: Mentis Verlag 2004. Pp. xiv + 292. ISBN 3-89785-439-2. •48.

Introduction

Michael Polanyi is generally regarded as having made a significant contribution to the philosophy of science by emphasizing the role of tacit knowledge in scientific practice. However, in more recent years, Polanyi's work has also been mentioned with regard to developments in various sciences regarding so-called 'emergent processes.'[1] In the following, I review four recent books that may be of interest to those interested in chaos theory, self-organization, and emergent processes. And though these books do not directly address Polanyi's ideas, they can be said to be written in his spirit. Andy Sanders characterizes the aim of Polanyi's work as "the restoration of meaning,"[2] indicating that Polanyi attempted to counter scientistic claims while arguing for the meaningfulness of the universe and a re-assessment of humanity's place therein. In other words, Polanyi aimed at a scientific redefinition of our current worldview. All of the following books can be said to be attempts to show how science itself has the potential to change our worldview.

Barr's *Modern Physics and Ancient Faith*

At least one cause of the recent interest in emergent phenomena is that many people have, and some scientists give the impression, that the sciences of emergent and self-organizing processes are preeminent among the scientific developments giving rise to a new worldview in opposition to the old, Newtonian worldview in which reductionism and materialism ruled supreme. Stephen Barr, a professor of physics at the

Bartol Research Institute, University of Delaware, argues that already the new physics gives reason to question the validity of the old worldview. Barr argues that our knowledge of the lower levels of our reality, those studied by physics, does not warrant the assumptions of reductionism and materialism. Admittedly, Barr's book is not so much about emergence, mostly regarded as a higher-level phenomenon. The emphasis of Barr's book is on materialism, and he argues that materialism "is not science. It is merely a philosophical opinion" (1). Materialism is not based on science but on certain assumptions about science – assumptions which may be questioned. In his book, Barr argues that physical data may very well lead to other conclusions.

In effect, Barr's aim is apologetic. Since materialism is an "anti-religious mythology" (4), debunking materialism may give room for religious reflections. But what is more, Barr argues that "science can by no means explain away the rich design of nature and its laws. Science has only shown that design to be more magnificent than anyone had ever dreamt. Therefore, the Cosmic Design Argument for the existence of God still stands. Indeed, it is stronger than ever before" (108). However, though Barr emphasizes design, he is not an exponent of the Intelligent Design movement, though he shows sympathy towards Intelligent Design by arguing that there is insufficient data "to prove that natural selection by itself is capable of doing the whole job of driving evolution" (110).

Barr thus not only argues that the old reductionist and materialist worldview is superseded by scientific data, leading to a new worldview, but also that religious reflection has a valid place within that worldview and is backed up by data from physics. His argument is divided in five parts. In the first part he describes that antagonistic relationship between religion and materialism. In the second part he describes how the Christian doctrine of creation resonates with the Big Bang theory. The third part deals with the question whether or not the universe is designed. Is everything the result of chance? But then, what about the highly ordered laws of nature? And what about beauty and symmetry in the universe? Design, in Barr's conclusion, is undeniable. The fourth part deals with the place of humanity in the cosmos. Barr explores the anthropic principle and the fine-tuning of the universe, which again is seen to be consonant with a theistic worldview. The fifth part, finally, deals with human nature, exploring questions about free will, the computational mind, and the connection between quantum theory and the mind.

The book is well-written and Barr is able to explain complicated theories in relatively simple terms. It could therefore be useful for introductory courses in religion and science. For most scholars working in the field of science and religion, however, the book does not cover new ground and its conclusions are not new.

Bird's *Chaos and Life*

Bird's book clearly arose out of dissatisfaction, or at least unease with the current Neo-Darwinian paradigm, which purports to explain the origination and evolution of life, but which is also unable to fulfill its promises – or so Bird claims. What Bird proposes in this book is, in effect, a new paradigm based on the sciences of chaos and complexity (or self-organization) and on the principle of *iteration*. Bird needs quite some pages to explain the principles of deterministic chaos and self-organization. He concludes that in chaotic and self-organizing systems, iteration is the crucial element. Mathematically, iteration entails that the output of a calculation is consistently used as an input for the next calculation. Hence, a feedback cycle occurs. Many chaotic and self-organizing systems are the result of iterative processes. Now, the title indicates that the book is about chaos and life. However, I believe that, apart from being a catchy title, it does not quite fit the bill. Although the book discusses chaos theory, it really is about one aspect of mathematical chaos, i.e., iteration.

Chaos is only used as an illustration to make plausible the idea that iterating a simple calculation may yield complex results.

Iteration clearly is a computational process, and here we encounter one of the consequences of Bird's approach: it might be (and Bird is suggesting that it actually is the case) that organisms are constituted by computational processes. Or, even more radically put, organisms are themselves "living computers" (as the title of the seventh and central chapter of the book indicates). In the cells of living beings, a computational process takes place using DNA (especially the repeat sequences, which in the 'old' paradigm are regarded as 'junk' DNA). Cells are thus something like a Turing machine. However, computational processes are not limited to the cellular level, but also cause emergent properties to come into existence. At those emergent levels, again iterative computations take place, yielding still more complex phenomena to occur. Ultimately, what we have here is a new worldview or metaphysics, the "iterative-sequential view" (258). Bird contrasts his new worldview with the current "random-selection" worldview (259). According to Bird, nothing happens at random, but all events follow a pattern which is based on iterative computational processes and procedures. Because our world is finite, true randomness cannot occur; at most some processes are pseudo-random. Seemingly random events or coincidences, which are inexplicable in the old random-selection paradigm, for the new iteration-sequential worldview are systematic phenomena (260); they are to be expected due to the self-similar structures of our world: "The same things will be expected to happen at the same time in different places; if they did not, the world would not be iterative" (254). Thus, since the current scientific paradigm, based on a combination of randomness (mutation) and selection, no longer suffices to make sense of the world around us, why not see our world as a giant computer? Though Bird cautiously speaks about his iterative-sequential view as a 'model,' he also is quite confident that this model is better able to make sense of our world than is the old, random-selection paradigm.

Bird's position in more than one way has affinities with Intelligent Design. Bird, in a sense, is proposing a Kuhnian paradigm shift which, ultimately, could result in a scientific revolution. In that sense, I found Bird's initial position resembling that of Intelligent Design theorist William Dembski, who aims at a new science without naturalist metaphysics and methodology. Also, as I see it, Bird's model could be made compatible with another idea from Intelligent Design. For, as Bird argues, organisms as living computers are built by nature: "This computer was designed [!] when the nucleic acids and their rules of manipulation evolved" (137). Though Bird casually speaks about 'nature' as having done the designing, theists might argue that it was God who breathed fire in the equations. However, in general, I believe that Bird is more of a naturalist than Intelligent Designers would like.

Bird's position also occasionally reminded me of Stephen Wolfram's bestselling *A New Kind of Science* (Champaign, Il: Wolfram Media Inc. 2002). By referring to cellular automata, Wolfram argued that the universe is a computer. Bird complements Wolfram's position in that he starts where Wolfram left off: with the practical implementation of the computational worldview in scientific research. This at once also indicates the problematic element adhering to both Wolfram's and Bird's position: determinism with reductionist tendencies. According to both Wolfram and Bird, everything in the universe is the result of calculations, and nothing happens that was not somehow in the equations governing the universe. If one would only know all the equations, as well as the initial conditions, one would have a "theory of everything" of the kind Stephen Hawking is looking for. Bird, however, is aware of the finiteness of the human mind, and argues that, though chaotic systems are deterministic, they are and forever will be unpredictable, because we have no complete knowledge of the initial conditions. He thus rightly concludes (on pages 56-58) that the Newtonian worldview,

in which determinism equaled predictability, is *passé*. Ever since Poincaré discovered the insolubility of the "three-body problem" we know that determinism does not entail predictability.

Bird, however, seems to wrestle with the consequence of a deterministic worldview. On the one hand, Bird adopts a metaphysics in which the universe is a "universal Turing machine," in which true randomness cannot occur. However, on the other hand, Bird still speaks about "mutations" in biological species, for instance the mutations that shape different species (145). In biology, the term "mutation" indicates a random event. However, though Bird seems to adopt the standard-use of the term in contemporary biology, since he argues at points that there is no genuine randomness in our universe, it is not clear in what way the term should be taken in his new "computed morphology hypothesis," as he occasionally calls his model.

Bird's book is interesting for its boldness, but that at the same time is its biggest weakness. There have been many books which argue that chaos theory and self-organization will revolutionize science, but what one sees so far is that scientists are perfectly capable of incorporating chaos and complexity within their current paradigm. Moreover, the idea that some structures in the universe may resemble Turing machines may have some scientific value (though this still needs to be proven – Bird's idea that junk DNA has a definite function in cellular computations still needs to be experimentally tested), but his metaphysical idea that our universe is a Universal Turing machine not only is counter-intuitive but Bird is incapable of presenting any hard scientific evidence to support that idea, besides pointing to dendrite structures that one often encounters in our universe.

Taking even more distance from the book, the implausibility of its thesis may also have something to do with the lack of definite structure, which can be illustrated by describing the different chapters. The first chapter introduces the mathematical concept of iteration. Then Bird goes on to describe how biology is in crisis (chapter 2 and 3). In chapters 4 and 5 all of a sudden we go back to a description of chaos theory and "chaostability." Chapter 6 describes fractals and the pervasiveness of fractal structure in the universe. Then in chapters 7 and 8 we come back to biology to introduce Bird's computed morphology hypothesis and its possible role in evolution. In chapter 9 we get a presentation of information theory, entropy and randomness. Chapter 10 is a philosophical discussion about the effectiveness of mathematical procedure in describing and explaining our universe. Chapter 11 is a short chapter about life and conflict, paradox and contradiction (frankly, in my view this chapter adds nothing but confusion and could easily have been left out). In chapter 12, finally, we get to the grand finale; here the metaphysical consequences of Bird's view are shown (including a discussion of mystical experience and God). In between there are expositions of the role of beauty, time and timelessness, ethics, Leibniz's monadology (which Bird in altered form adopts), and what have you. I must admit that at the end of most chapters, Bird gives a small summary of the main ideas of the chapter, which aids in retracing one's steps. Still, I believe the structure of the book is quite confusing and would have benefited from some sturdy editing.

The Significance of Complexity

What are the consequences of complexity science for the humanities? This question is the focal question of the book edited by theologian Kees van Kooten Niekerk and physicist Hans Buhl. The book is the product of a series of lectures organized by the Danish Science-Theology Forum in 1999-2000. In this book, the concept of complexity is approached from three perspectives: the natural sciences, the humanities, and theology. An introduction by the editors provides for the uninitiated a clear and concise introduction to the

concept of complexity, as well as an overview of the various articles.

The scientific part of the book contains articles by Claus Emmeche, Thiemo Krink and a joint article by Hinnerk Boriss and Volker Loeschcke. Emmeche's article stands out in giving an in-depth view of complexity science which in a sense builds further upon the introduction of the editors. Krink describes the valuable role of computer modeling in complexity research, while indicating that computer modeling has its limitations. He warns us especially not to confuse models with reality. Boriss's and Loeschcke's article argues that complexity theory can promote a more holistic understanding of biological systems. This is illustrated by looking at the stress response in vertebrates and invertebrates. Boriss and Loeschcke develop their argument in such technical manner, that it is out of balance with the level of most other papers in the book.

The two articles comprising the humanities section seem promising but are disappointing, as they only encompass aesthetics and philosophy. Bo Kampmann Walther attempts to give us insights into the role of complexity in interactive art, but the terminology which he uses clouds his argument in obscurity. Psychologist and mathematician Hans Siggaard Jensen shows how complexity leads to the acknowledgment that we can only make sense of the world using different descriptions and explanations. The most we can gain is a kaleidoscopic view of the world, and a unifying account seems impossible. Though Jensen's article raises some interesting, though familiar points (some of which were already made by Nicholas Rescher and are also made by Niels Henrik Gregersen in his contribution), I was not sure why the editors put the article in the humanities section, since it is basically a critique on the aims and methodological assumptions of the natural sciences.

I found the third section, dealing with theology and complexity, the most interesting. Niels Henrik Gregersen explores the various ways in which the sciences of complexity are relevant for theological reflection. This exploration proceeds in three stages: first, an exploration of seven different kinds of complexity; secondly, a critique of Wolfram's (and, implicitly, Bird's) notion that the universe is a computer (though Gregersen admits that computers are useful in describing and explaining the workings of the universe); and thirdly, a Trinitarian exploration of complexity regarded as the workings of the activity God. Günter Thomas, in the second paper of the section, uses the sociologist Niklas Luhmann's ideas about complexity, and argues that theology is 'hyper-complex' in the sense that it not only reflects upon the complex world, but also entails a self-reflection. To reduce the complexity, theology focuses on some specific relations, specifically the relation between theology and the Bible. How such a complexity reduction works is then shown by looking at how the biblical notion of new creation can be the focus of the interaction between science and theology. I admit that the point of this article to me was not entirely clear, but that might have something to do with my lack of knowledge of Luhmann's theory (which is extremely complicated). In the final paper of this section, theologian Wentzel van Huyssteen addresses the idea of 'human uniqueness' in science and theology by looking at scientific theories about the emergence of our cognitive capacities. He argues that from a scientific perspective, the split between humanity and the rest of creation is absent. Yet Van Huyssteen believes we are entitled to speak about human uniqueness when looking at the interaction of specialized modules in the human brain that is responsible for the emergence of art, technology, religion, and science and other aspects of human culture.

Overall, this is a valuable book, since it addresses the interaction between concepts from the natural sciences and the humanities. It contains some outstanding papers, notably the Introduction and the papers by Emmeche, Krink, Gregersen, and Van Huyssteen. Nevertheless, I also am critical in that some articles (such as those by Boriss and Loeschcke, and by Walther) should have been thoroughly edited. However, my biggest criticism is methodological: the input from the humanities could (and should) have been bigger. Every article still takes its lead from the natural sciences, thereby implicitly emphasizing the priority of the natural sciences in academia.

Stephan's *Emergenz*

Stephan's book on the historical and philosophical aspects of the concept of emergence is, in my opinion, the most interesting of the four. This book is a revised version of Stephan's *Habilitationsschrift* at the University of Karlsruhe. However, unlike most German *Habilitationsschrifte*, Stephan's book is relatively short (less than 300 pages) and is written in a clear, non-technical style.

Stephan begins by tracing the historical context in which reflection about emergence took place early in the twentieth century. This is the debate between mechanist and vitalist worldviews. As a middle way, Samuel Alexander, Conwy Lloyd Morgan, Roy Wood Sellars, and Charles Dunbar Broad came up with the concept of emergence. Stephan identifies nine characteristics of their use of the concept of emergence and systematically analyzes their interrelations. It is quite striking to find out that, unlike many emergentist thinkers nowadays, these early emergentist thinkers were quite drastically committed to a deterministic worldview. The result of Stephan's analysis is a concise and useful 'map' which charts the different theories of emergence and their emphases.

Next, Stephan traces the beginnings of British emergentist thought in J.S. Mill's *A System of Logic*, while also pointing to Continental theories of emergence. He outlines and analyses arguments against emergentist theories and evaluates counter-arguments. Thereafter, he explores the contemporary renaissance or 'second wave' of emergentist thought, in philosophy of mind, the sciences of self-organizing systems, and chaos theory (arguing that, ironically, chaotic behavior may have more emergent characteristics than the self-organizing processes described in many contemporary complexity theories). Stephan predicts that this wave of interest for emergence will remain for a while.

For me this book has become a primer on emergence. A minor flaw may be that the author nowhere specifically characterizes the difference between 'emergence' and 'supervenience,' or that he does not really develop a position of his own with regard to the usefulness of the concept of emergence in scientific literature (which, in personal communication, Stephan argued, was caused by his doubts about the scientific usefulness of the concept of emergence). But these are merely minor points. The book's strength is that it provides a rigorous philosophical analysis of emergentist theories past and present, as well as a critical and systematic apparatus which can be used to evaluate contemporary and future emergentist theories. Unfortunately for many in the English-speaking community, the book is written in German. However, for those interested in acquiring an English version of this book there is also good news, as an English translation is in preparation, probably due for 2006.

Notes

[1] See, for instance, the responses to Philip Clayton's contribution in *Tradition & Discovery* 29 (2002-2003), Andy F. Sanders's 'On Reading Part IV of *Personal Knowledge*: a Finalism or a Simple Vision?' (*Tradition & Discovery* 30 (2003-2004), 24-34), and Phil Mullins, 'Polanyian Footnotes to "From Biology to Consciousness to Morality"' (*Tradition & Discovery* 30 (2003-2004), 22-30).

[2] Cf. A.F. Sanders, *Michael Polanyi's Post-Critical Epistemology: A Reconstruction of Some Aspects of Tacit Knowing*. Amsterdam: Rodopi 1988, 227-229.