Intelligent Design and Complexity Research

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Many thinkers have wondered whether biological systems are too complex to have arisen naturally. From these speculations a group, composed largely of Christian scholars, have constructed a point of view which rejects the scientific program of understanding the entire world in terms of natural processes. In arguing about this point of view, called Intelligent Design or ID, it is tempting to talk about it as a tool in a political movement, tending toward the construction of a creationist alternative to the scientific world-view, and thence toward various controversial changes, including major redesigns of U.S. school curricula[1].

This article does not look down that primrose path. It looks specifically at a recent book by William Dembski[2] entitled *No Free Lunch*, which discusses the complexity of living things from the point of view of ID. The book argues both about the generation of the first life and also about the very complex structures within existing organisms. Here, I try to follow the thinking of Mark Vuletic[3] and ask what science can gain from ID, and particularly from Dembski's book.

Dembski's argument is a quantitative and mathematically structured form of William Paley's watchmaker argument[4]. Think of the development of a species through time as a motion thorough a very large, but discrete, space in which the different points represent different possible genotypes. The species gains local information about the space including something about fitness at the different points and uses some strategy to

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hunt for a state of better fitness. In this restatement of Dembski's picture, I have glossed over intraspecies genetic variation, reproduction, death, sexuality, and much else.

The result of this search must be quite remarkable. The organisms we see around us have raised themselves to states of amazing complexity. In fact, the configurations of viable organisms must be breathtakingly rare in the space of all possible DNA chains of a given size. Dembski uses the words "specified complexity" to suggest the nature of the organisms and the fact that they are observed to have a magnificent degree of organization. The scientific view is that the organisms reach this state by utilizing an appropriately designed "Darwinian" algorithm to search through this space for really nifty designs: alligators, albatross, aardvarks, and people like you and me. But, Dembski notes that a theorem gets in the way. In the 1990s David Wolpert & William Macready proved a set of "no free lunch" theorems which show that for a "typical" form of the function describing how the fitness depends upon the position in the space, there is no search algorithm which works better than a examination conducted at random[5]. And it is easy to see that a random search could not, in the available time, produced anything like the complexity one finds in the simplest virus. So, the biological theorist Stuart Kauffman in his *Investigations* (Oxford University Press, 2000) says that the world must contain the right sort of fitness functions, relatively smooth ones appropriate to produce a better and quicker search process. In addition, for evolution to work, there must be a good correspondence between fitness function and search algorithm. But, no algorithm can work if the landscape is so rough that it offers you no hint of far-away behavior. So Kauffman escapes the theorem by using a smoother landscape.

Dembski, in turn, noted an elegant way of escaping from Kauffman's argument. He says that a smooth fitness function is very unlikely. But we seem to see smooth functions in nature. So Dembski more or less says "who ordered them?". He asserts that putting the onus for an effective evolution on smooth functions just postpones the design problem to a different level. And on that level, Dembski demands that we accept the view that ID is the only reasonable answer.

In my view this mode of argument is fully within the traditions of science. Even the invocation of an implausible explanation at the final stage, when the more plausible ways out have been eliminated, is perfectly reasonable and traditional. Faced with roughly this same dilemma, Fred Hoyle punted by suggesting the extraterrestrial origin of life.

For myself, I won't look for early life in outer space and I don't believe ID. Not yet anyway. I'll need a lot more evidence to be pushed that way.

Neither Dembski nor Kauffman nor Wolpert & Macready can provide theorems which directly deal with the evolution of life. "Specified complexity" is somewhat elusive and, I think, cannot be defined with sufficient specificity to appear in the premise of a strong theorem and at the same time describe real life. The theorems of Wolpert & Macready only apply to a generic fitness functions. Any actual fitness function in a prebiological evolution process must be in the first instance an output from a physical process. The connection between process and function is very imperfectly known. So we are pushed to ask about the nature of the physical processes which go into the production of the first stages of protolife. Then, as we get into real living things, we ask about how additional complexity might grow upon an initial complexity.

Recent work on physical systems provides some hint about how biological complexity arises. For example, computer studies simulate the cosmology formed soon after the big bang[6]. These studies construct entire universes, intended to be reasonably realistic, within the computers. The models start out with dark matter and baryons spread out rather uniformly. Weak Gaussian fluctuations are put in as random spatial waves. The models then simulate Newtonian motion within an expanding universe. Gravitational instabilities compress regions of high mass density and thereby bring together clusters on a variety of scales. Step by step the computers make objects down to the size of galaxies, which even look reasonably realistic. In this way, very rich complexity, but perhaps not Dembski's "specified complexity" has been constructed within a computer program.

Conversely, several studies have looked for increasing complexity and failed to find it[7]. It is likely to be true that some degree of richness in the governing equations is required in order to find a cascading complexity. Fluid flow apparently has enough complexity, especially when enriched with chemical or thermal processes. In my own work[8], I have emphasized the amazing complexity which can arise in a Rayleigh-Bénard cell, where turbulence and thermal effect can work together. These cells engender a multiplicity of structures: mushroom-like plumes, jets, boundary layers, waves, and unexpected reversals of all-over motion. Certainly these structures show a degree of complexity much weaker than that observed in biological systems. But I would argue that the degree of complexity is such that one might begin to doubt the relevance of the free lunch theorems to these systems and by extension to biological systems.

These studies do, I think, isolate questions about physical systems which might, in the end, have some relevance to our understanding of the development of biological systems. We should wish to know: When will physical processes generate a cascading growth of complexity? Are those cascades "rare" or "likely"? Indeed there is considerable research which shows that chaotic, dissipative physical systems will generate a complex structures. Important work related to these issues has been done by Katchalsky[9], Prigogine[10], Kauffman and many others. But biological systems should many different levels of organization. Can chaotic physical structures, for example plumes, combine together and "self-organize" to produce higher levels of structure--say a weather system? Does this cascading of levels of structure occur generically? When does it cut off? Can it produce things of truly great complexity?

Such questions form the nub of a research program which is, in fact, in progress as parts of different fields and disciplines. The work is diffuse, complex and, appropriately, largely self-organizing. It might provide some parts of the answers to the questions asked by Dembski and his collaborators in the world of ID.

We scientists should indeed encourage the godly to quote science for their own purposes. Incisive and persistent questioners make for good answers.

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1. For worries about where ID will bring us see a pair of articles in the June 2002 *Physics Today ,* Adrian Melott's "Intelligent Design is Creationism in a Cheap Tuxedo" pp 48-50 and Mano Singham's "Philosophy is Essential to the Intelligent Design Debate" pp 48-51. See also the references contained in these articles.

2. William A. Dembski *No Free Lunch: Why Specified Complexity Cannot be Purchased without Intelligence* (Roman and Littlefield, Lanham, Maryland, 2002). See also the earlier work William A. Dembski, *The Design Inference: Eliminating Chance Through Small Probabilities* (Cambridge University Press, Cambridge, 1998.) I suspect myself of some bias in favor of Dembski since he was, for a brief period, my student.

3. http://www.infidels.org/library/modern/mark_vuletic/dembski.html

4. William Paley *Natural Theology* (1802; reprinted Gould and Lincoln, Boston, 1852.)

5.David H. Wolpert abd William G. Macready "No Free Lunch Theorems for Optimization" IOEE Transactions on Evolutionary Computation 1(1) (1997):67-82.

6. For a review see Edmund Bertschinger, "Simulations of Structure Formation in the Universe" Annual Reviews of Astronomy and Astrophysics **36** 599-654 1998

7. For example, studies of the discrete dynamical systems called Kauffman K-N models have shown only the most limited growth of complexity, see Boolean Dynamics with Random Coupling, L. Kadanoff, S. Coppersmith, and M. Aldana-González, preprint (2002).

8. See August 2000 Physics Today.

9.A. Katchalsky and P.F. Curan, Nonequilibrium Processes in Biophysics (Harvard University Press, Cambridge, Mass., 1967)

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10.G. Nicolis and I Prigogine Self-Organization in Nonequilibrium Systems (John Wiley, New York, 1977)