Roundtable Discussion
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A Roundtable on Nature's Destiny

Thirteen years ago, a book by a largely unknown Australian biologist and physician, Michael Denton, was published in London: *Evolution: A Theory in Crisis* (Burnett Books, 1985). The American edition appeared a year later (Adler, 1986), and soon won a wide and appreciative audience. Among the readers strongly influenced by the book was Phillip Johnson, who while on sabbatical in England read *Evolution* (shortly after reading Richard Dawkins's contemporaneously published *The Blind Watchmaker*), and Michael Behe, both of whom found the book revelatory. Denton offered a systematic critique of neo-Darwinism, evaluating skeptically both the mechanism of evolution, and the patterns of evidence (fossil, embryological, anatomical, molecular) usually adduced in support of the theory of common descent.

In August 1998, Denton's eagerly-awaited second book arrived: *Nature's Destiny: How the Laws of Biology Reveal Purpose in the Universe* (Free Press, 1998). Readers expecting a continuation of the arguments of *Evolution: A Theory in Crisis*, however, found a line of argument markedly different from the earlier book. Although much of Denton's skepticism about neo-Darwinism remained, gone were the challenges to the theory of universal common descent--i.e., the common ancestry of all terrestrial organisms--which had made Evolution especially controversial with mainstream biologists. In their place was an unstinting advocacy of common descent, and a notion of "directed evolution" in which the historical unfolding of life on earth was "built into" the universe from the start.

Denton's new ideas appeared under the banner of design. Moreover, he is a member of the editorial board of *Origins & Design* and has interacted extensively with intelligent design theorists at conferences and in correspondence. Thus, the editors of *O&D* thought it would be helpful to organize a roundtable discussion of *Nature's Destiny*. The participants included Paul Nelson as moderator, and, as respondents, associate editors Jonathan Wells, William Dembski, and Stephen Meyer, and editorial board members Phillip Johnson and Michael Behe.

Nelson: Mike, let's start with you. What do you think are the strengths of Denton's case?

Behe: He brings together what we have learned over much of the past half-century, and shows how that knowledge extends the types of design arguments of the early nineteenth century, showing that in fact the universe does appear specially designed for life. The more we discover, the more we see that factors of the universe that we thought were interesting, but not important, turned out to be vitally important.

50 to 70 years ago, for instance, we didn't know about the weak and strong nuclear forces--yet now that we've discovered them, we know not only that such forces exist, but that they appear to be what is called "fine-tuned" for life: meaning that if they were even slightly different, life as we know it would be impossible. Denton looks at such evidence from a whole range of sciences, such as physics, chemistry, geology, and biology.

Take Denton's discussion of water, for instance, which expands nicely on Lawrence Henderson's 1913 account from his classic *The Fitness of the Environment.* Now here's an everyday and seemingly banal fact: ice--frozen water--floats. Nearly all other fluids, however, contract when they freeze, becoming more dense, and then sink. But water, just before it reaches its freezing point, expands and becomes less dense, so that it floats. If water didn't have this property, the oceans and all other bodies of water would freeze permanently from the bottom up, and life would be impossible. And water has other amazing properties, too. If the viscosity of water were much higher, nutrients would diffuse into cells much more slowly, and the movement of organelles such as mitochrondria and cilia would be much more difficult. The high heat capacity of water lets it act as a heat sink, while its latent heat of evaporation enables large, warm-blooded organisms, like you and me, to excrete excess heat. The surface tension of water is necessary for the weathering of rocks to form soil, to draw water to the top layers of soil, and for the formation of lipid membranes. I mean, one can go on and on: the importance of water as a solvent, its proton conductivity, its chemical reactivity--virtually all of water's properties are necessary for human life.

Nelson: OK. But let's imagine that we've got a couple of skeptics listening to our discussion. What they're going to say, I think, is the following. Denton has done nothing more than survey, *post hoc*, the necessary conditions for life.

Yes, it's true that water for instance has these apparently miraculous properties in relation to human biology, or in relation to living things in general.

But the causal story is all wrong. It's being told backwards. One ought rather to say that water came first, and it just so happens that life arose with water already present in the environment. Of course the features of water seem fine-tuned for life. Organisms evolved making use of the properties of whatever raw materials were available, including water. But if one begins the story at the beginning, as one ought to do, natural events simply follow each other in ordinary succession. That we humans are here now, and exist, is certainly the consequence of what came before us, but in no legitimate sense can we look back through time and say that those events were fine-tuned. They just happened to turn out as they did. The appearance of fine-tuning or design is only an illusion caused by looking back over a long sequence of contingent events-- "contingent" in the sense of a lottery outcome. Luck rules, all the way back.

In other words, I think skeptics will object that a *post hoc* fallacy runs throughout what Denton is arguing. What's the old joke attributed to Abraham Lincoln?-- "Isn't it wonderful that my legs are just long enough to reach the ground?" Or, as Bertrand Russell says somewhere, to listen to teleologists, one would think that noses were

designed to support spectacles, as every pair of spectacles we observe in fact reside on someone's nose.

Behe: That's a weak argument. We've known about water and other things for a long time, and we took them pretty much for granted. But the more we learn about them, the more we find out that if water had been a teeny tiny bit different, life would not have developed. So, it's not just that there are a number of factors that are needed for life, but it's the extreme improbability, or, to put it another way, the extremely precise specification of all those factors necessary to produce life that is the striking discovery. If water were the liquid of life, and yet its properties could vary by a factor of a thousand or a hundred thousand in capacity and still produce life, then water wouldn't be so remarkable. However, if water had to be structured precisely as it is--well, that's what makes one sit up and take notice. Denton's arguments are similar to what we've been hearing from physics over the past couple of decades. It's not simply that there is such a force as gravity or the weak force or so on. Rather, if the weak force, to take an example, had differed by one part in 10^{60}, then life would not have started.

It's not just that these forces are necessary factors for life, but that their precise features are balanced very carefully for life.

Nelson: Anybody else want to speak to that?

Meyer: I agree with Mike on this. I don't think Denton makes the connection between his evidence and an intelligent designer as clearly as perhaps some of us would like, but he's pointing to the same evidence that other design theorists have pointed to--namely, you have very improbable events which are also necessary in the sense that they are specified independently by the functional requirements of the living system. And in that evidence is the improbability that Mike spoke to, as well as the specification which Bill Dembski would insist is there. Conjoined, the small probability and specification yield a design inference. Now Denton doesn't make the theoretical basis for that conclusion explicit, and I think his attempt to root biological design in natural law is problematic, but the evidence is no different in that kind from that sustaining standard design reasoning.

Incidentally, the skeptical objection you gave is typically known as the weak anthropic principle, and it does not remove the need for an explanation for apparent fine-tuning. The weak anthropic principle merely cites the necessary conditions of life and treats them as if they constitute the cause of life. But, a necessary condition is not a cause.

Advocates of the weak anthropic principle say, "Well, if all the necessary conditions for life are present, then life must have come about." But that doesn't follow. The fact that the necessary conditions are so improbable and independently specified suggests to my way of thinking that intelligence is a better explanation, because only intelligence can choose one outcome rather than another.

Nelson: Why then does Denton never make the connection to intelligence--at least not explicitly?

Behe: Can I jump in for a second? Maybe I'm reading things into the book, but I certainly got the strong sense--perhaps Denton didn't state this explicitly, but he does so implicitly--that he was arguing for the relevant choices being made by an intelligence.

Let me give you some background. During the April 1996 meeting at the Ethics and Public Policy Center, in Washingon, DC, where Denton and I both spoke, he said to the whole group of journalists and other folks there that he thought God had set up the universe to produce human beings.

Moreover, the night before that meeting, Denton and I had dinner at Tom Bethell's house. I told him that I had read his manuscript--at that point, the book was called *Biology, The Anthropic Perspective*, with the subtitle, *An Essay in Natural Theology*--and that I liked it very much. He was pleased. Then I said, "But there just one thing that bothers me. For a natural theology, it doesn't mention God." Denton seemed a bit startled by that, and he said, "Well, I certainly believe in God, and I think God did this. I was just trying to style the arguments in the fashion of the natural theologies of the early nineteenth century." So it seems pretty clear to me that Denton in fact sees the evidence for design as pointing, ultimately, to a transcendent intelligence.

Nelson: Given what you've said--and I recall his remarks from that Washington meeting, too--I think you're probably right. There's a significant tension in *Nature's Destiny*, however, between what I would agree is its implicit theme, design as being transcendently caused by an intelligence, and Denton's desire nonetheless to attribute that design solely to natural laws or natural processes.

None of us could have missed the statement in italics right at the beginning of the book, which Denton places in his introductory "Note to the Reader": "The cosmos is a seamless unity which can be comprehended ultimately in its entirety by human reason and in which all phenomena, including life and evolution and the origin of man, are ultimately explicable in terms of natural processes" (p. xviii). Denton says his whole project is "entirely consistent" with this "basic naturalistic assumption," which he places in opposition to what he calls the "special creationist school." I think this necessitarian or deterministic conception of design raises problems. Comments?

Behe: I would agree. Here's an analogy I used in my review of the book for *Perspectives in Biology and Medicine*. The gravitational constant and coefficient of friction of the pool table may enter precisely into a sensational trick shot by Minnesota Fats, but they do not completely account for it. To explain the event, you also need to refer to Minnesota Fats as a cause. Likewise, the origin of life on Earth may depend on the viscosity of water, the chemistry of iron, and other physical factors, but those factors by themselves do not explain how life started. As Steve said, a necessary condition is not a cause.

Dembski: Yes, necessary conditions are not sufficient conditions. That's a real problem with Denton's argument. Before I get to that, however, let me say that I think Denton does a masterful job of spelling out those necessary conditions that do require

explanation. And, indeed, necessary conditions *can* require explanation, *contra* the weak anthropic principle, the skeptical position Paul outlined at the start of our discussion.

Here's a story from John Earman illustrating the point. One can find the same sort of example, incidentally, in the writings of John Leslie, with whom it is original, as well as in Richard Swinburne and Bill Craig. Earman writes, "Harry's car skidded on wet pavement, jumped a guardrail, and started to plunge over the edge of a cliff towards the rocks 100 feet below. Harry awoke between clean sheets [after the accident] to find to his amazement that there were no broken bones. There is, of course, one rather uninteresting sense in which Harry should not be surprised: namely, he shouldn't be surprised that he is *observing* that his body is not a mangled mess since if it were he would be unable to observe it." Now, that's the weak anthropic principle in a nutshell. Conditions must be such that we are able to observe our own existence.

But, as Earman goes on, "On the other hand, Harry has every right to be surprised and puzzled by the *fact* that his body is not a tangled mess. Similarly, those physicists and philosophers who profess amazement at how 'finely tuned' the laws of nature are in favor of life"--like Denton, for instance--"are hardly going to be satisfied by a demonstration that the confinement of the values of the fundamental constants to narrow ranges about their actual values is necessary for life as we know it; indeed, that demonstration is precisely the source of their puzzlement." In short, that we can *observe* our own existence does not *explain* our existence.

Having said this, I think there's a serious confusion in *Nature's Destiny* between necessary and sufficient conditions, a confusion related to Denton's deeper goal of explaining life only in terms of natural regularities. "Creation by law," or "design by law"--that's what Denton is after. It reminds one of the ideas circulating in the early 19th century. God designed the world, to be sure, only he did so through natural laws. Denton cites the pre-Darwinian teleological evolutionist Robert Chambers favorably, and calls his idea of "directed evolution," as elaborated in Chambers's *Vestiges of the Natural History of Creation* (1844), "immensely attractive" (p. 272). The idea may be attractive, but I'm afraid it just doesn't work. Natural regularities, or the necessary physical conditions which Denton discusses, by their very nature cannot generate the specified complexity required for life.

Meyer: Exactly. To locate design in natural law reflects a fundamental theoretical incoherence. Laws are, by definition, descriptions of repetitive patterns of events. But life is characterized by specified complexity: the aperiodic, information-rich sequences of DNA and proteins, for instance, which appear nearly random to standard information theory. Life is anything but simple and repetitive. In trying to explain these biological objects via natural regularities, Denton trips over a basic problem.

Dembski: One can also understand natural law in a more general sense, of course, which lays the emphasis on the mechanistic or causal autonomy of nature. God doesn't need to intervene to make the apple fall, because gravity is available to do that. And, on Denton's

account, presumably, God doesn't need to intervene to create life, because some unknown self-organizing principle will do the trick.

But this whole notion of "design by law" turns out to be an unstable equilibrium.

If one focuses on "design," then one looks for a designer--an intelligent agent--who will act at some point or another, even if only at the beginning of the story; and then laws fail. They're insufficient. If one focuses on "law," on the other hand, meaning the actual natural regularities, the designer inevitably fades away into a brute natural process. In fact I think this is what happened to the natural theologies of the early 19th century, which Denton admires. Science said, in effect, 'Well, we can see the laws in action, anyway. Parsimony would tell us that the laws are sufficient, and to drop the designer as superfluous.' The equilibrium tipped in favor of autonomous natural processes, and the designer lost his job. Permanently, say the philosophical naturalists. It is hard to see how Denton's argument can avoid a similar fate.

Johnson: I'll say something about that momentarily. But first I want to turn back to the evidence for design. The book really brought home to me how much appearance of design there is in the natural world, outside of biology. That water example which Mike Behe mentioned is a good one, although as Denton notes, it's not original with him--he does however bring the various threads of evidence about water together in a wonderful way.

And the appearance of design, with water and so on, Denton says, is more than an appearance. What appears to be the case really is the case: the design is real. But that's what everybody took for granted in the seventeenth century, or for that matter up until the middle of the nineteenth century. Newton, for instance, thought that, as the Bible said, the world was created by an intelligent cause.

Science tries to figure out the details, but the basic assumption of design went without questioning. Of course, David Hume later comes along and says, 'Listen, we can't know anything for certain, this is the only universe we have, design isn't knowledge,' and he encourages a general skepticism. But his position never took root, because that degree of skepticism is too thoroughgoing. In particular, it undermines any kind of empirical science. In fact you end up not believing in your own existence. There's nothing left to do but go to the tavern and play checkers.

Then Darwin comes along. He sets in motion a whole intellectual tradition which says, we can account for the appearance of design--which, for Newton and others was real, of course, not simply an appearance--by rendering it the product of chance and natural law. And the Darwinian program of dissolving design into "not-design," or blind natural processes, remains the dominant system of explanation today. But right from 1859 to the present there has been in the background a radically dissenting view, with which I associate myself, that says, look, with Darwinism, science has gone way beyond what it can reasonably establish. The evidence actually to support the claim that the complexity and diversity of life can be explained by purposeless natural processes just does not exist.

What really happened was the Darwinians changed the rules of science, in a way that left purposeless material or natural processes on the field as the only causes to which one could appeal.

Now, one may accept that change of the rules, but then I would argue that one is going to have to leave really important stuff, like the origin of life, outside the materialist scheme of scientific explanation. People within the scientific establishment hate that kind of talk, however, because it challenges their power base, their prestige, their self-esteem.

So what comes along, understandably, is a more modest approach. There are plenty of people who say, 'Well, maybe Darwinism isn't true, but we can nevertheless solve the problem of the origin of biological complexity without making any deep changes in the foundation of science. The solution lies somewhere within the boundaries of those philosophical assumptions acceptable to naturalistic science.'

You can put this all in political terms. A guy like Michael Denton can say, 'I'm fundamentally with "us," the mainstream of the scientific community, rather than with "them"--the creationists or whomever--on this issue. I just don't believe the Darwinian angle.' And I don't object to that. Indeed I welcome it, because it's stirring the pot, so to speak.

But that brings me to my bottom line. Does a project like Denton's have any possibility for success? That is, can you domesticate the design critique of Darwinism? And I would say no. It can't be done. People will try to do it, of course, with the most honorable of objectives--critiquing Darwinism but keeping strictly within naturalism, in order to gain a hearing from the naturalistic community--but in the end the attempt will fail.

The problem is, there is no non-Darwinian natural mechanism available to do the work of building biological complexity. There's no alternative science to be done using Denton's approach. So, if one asks, what are scientists actually going to do with Denton's ideas?--well, I don't think there is any prospect for their success *as science.* The restrictions of naturalism draw one back quite inevitably into the Darwinian program, or something very much like it. There is no intellectually viable midpoint between naturalism and intelligent design.

Nelson: Jonathan, we haven't heard from you yet.

Wells: OK. Well, I have the advantage of having listened to all of you first.

Let me start by saying that I think the book will have a good effect on discussions about this topic within the academic community. Even the tentative steps Denton takes in the direction of intelligent design, limited as they are by his contradictory goal of wanting to uphold naturalism, as you guys have noted, will have tremendous repercussions. It's hard for me to imagine Stephen Jay Gould liking this book, for instance, because Denton so clearly wants to talk about ideas we're supposed to have left in the dusty shadows of the

scientific past. In that respect--in taking seriously, even if confusedly or imperfectly, heretical notions like design--I think the book does very well for itself.

Here's a passage, for example, that I think would make any evolutionary biologist want to pull out his hair. "It is not that life adapted to oxygen or to the atmospheric conditions on the earth, but rather that long ago, long before the first organisms, long before the formation of the earth, the design of oxidative metabolism and the general character of the atmosphere of our planet was already built into the order of the cosmos" (pp. 130 – 131). Now that's good old-fashioned teleology with a kick to it. And I want to endorse pretty much everything Denton has to say about physics, chemistry, and geochemistry--that is, the stuff up to the end of Chapter Six, laying out the case for the design of natural laws and regularities. Then I think his argument goes badly off its track.

Nelson: Why?

Wells: I'll reiterate what everyone else has said so far. While life as a phenomenon presupposes natural laws and regularities, and on that score I think Denton's argument is compelling, those same laws and regularities do not explain life's origin or its essential character. The analogy I like is architectural. A 2-by-4 is superbly fit for use in the construction of a wood-frame house; no question about it. But having a pile of 2-by-4s in no way makes a house inevitable, much less any particular house.

Physical fine-tuning, in other words, will only take one so far. Organisms are physical systems, sure, but of course they are also so much more than physics. Or even chemistry. Or even biochemistry.

You'll notice that there is a big jump, a chasm, really, in Denton's overall argument, which he himself admits in the "Note to the Reader". His conclusion of design via natural law "is not materially threatened," he says (p. xvi), "because the whole picture is not yet complete or because this or that phenomenon such as the origin of life or the mechanism of evolution is not understood." But that's a bit like saying to one's client, 'Laying aside a couple of details, such as the plan and the actual construction, that pile of lumber over there is your new house.' I think Denton fails utterly to demonstrate his thesis, namely, that life is the inevitable or pre-programmed outcome of natural regularities. Actually he doesn't even try. His discussion of the origin of life, for example, is quite abbreviated, and mostly criticizes the shortcomings of existing naturalistic theories.

I also disagree with his view that not only the DNA molecule, but also the specific sequences in DNA, are inevitable. Here the argument is not only lacking, I think it is impossible to make.

Meyer: Could I say something about that? Denton talks favorably about Stuart Kauffman's self-organization theories for the origin of life, saying that "from a teleological perspective the origin of life *must* be viewed as something quite inevitable and built into the laws of nature from the beginning" (p. 296).

But the highly specified, improbable, information-bearing sequences in DNA are no more inevitable or law-like than are my words right now. As I note in one of my papers, quoting Fred Dretske, as the probability of a state of affairs approaches 1.0, the amount of information associated with that state of affairs goes to zero. Denton wants to explain life by reference to natural laws or regularities--but laws have associated probabilities of 1.0, or very nearly 1.0.

They're poor generators of complexity, which by definition is equivalent to low probability, that is, to probabilities far less than 1.0. Laws are also exceedingly poor generators of *specified* complexity, such as characterizes all living things. By trying to locate the source of biological design in "programmed law," Denton commits himself to an inadequate cause. Inadequate in principle, you might say. Really, he's no better off, scientifically speaking, than any conventional self-organization theorist who never uses the word "design." Natural regularities just aren't up to the task of creating specified, aperiodic sequencing--that is to say, information.

Wells: Yes, I agree, but Denton obviously has great faith in self-assembly.

He says at one point, for example, "Cytoplasm has not been created by natural selection," but rather "is an inherent property of an aqueous solution of the constituents of the cell" (p. 222). Now that's not exactly the origin of life, but it's sort of the last step in the origin of life. And I don't believe that for a minute. You could mix all the chemical constituents of cytoplasm together in a test tube, and you're still not any closer to a cell than when you started.

Meyer: The irony for me in what you are saying, Jonathan, is that Denton himself explained this to me very clearly back in 1988 at the "Sources of Information Content in DNA" conference in Tacoma. Then he called it the "problem of emergence." He explained that at every level, the properties of lower level constituents do not determine the properties of the higher level systems of which they are a part. The properties of atoms are necessary but not sufficient to many molecules, the properties of molecules are necessary but not sufficient to biomacromolecules (like protein and DNA), the properties of DNA and protein are necessary but not sufficient to the higher-level organization in the cytoplasm.

I think this point is most applicable in relation to pre-biotic chemistry and the building blocks necessary for life. Look at the constituent parts of the DNA molecule, for example. Its bases--adenine, thymine, cytosine, and guanine--can, from a chemical point of view, be arranged and rearranged in equiprobable ways along the sugar-phosphate backbone, just like Scrabble pieces on a playing board. There are no self-organizing chemical properties at the level of nucleotide chemistry, nor are there chemical laws, that can explain the specific sequencing that is necessary for coding functional proteins rather than molecular rubbish.

To bridge the gap between the necessary building blocks and a functionally sufficient sequencing, I think Denton needs agency: an intelligence to elect one or a few particular

outcomes from the vast sea of combinatorial possibilities allowed by natural law. Natural necessity or law won't do it.

Wells: The problem is, even if we charitably granted Denton the DNA, it wouldn't yield a cell. And even if we granted him cells--bacteria, let's say--there's no reason why the narrative should move beyond that. Any novel step along the way to human beings is not going to be the inevitable outcome of natural laws, because any step along the way, above the very limited threshold accessible to natural regularities or chance, must be specified. And that requires intelligent design.

I should also say something about Denton's uncritical advocacy of the "DNA program" view--the theory that the form of organisms is completely encoded by a molecular blueprint stored in their genes. One can find this, for instance, on page 275, where Denton writes, "Every living organism is specified in a precisely determined way by a set of instructions encoded in the sequence of bases in its DNA." This goes hand-in-glove, by the way, with his notion of "a long-term evolutionary program" (p. 276), according to which macroevolution unfolds over time, somehow unspooling a program stored in the genome of the first organism. I'm skeptical of both ideas, because I think the evidence fails completely to support either. First, as I've written in several articles, I don't think there is any good evidence that the macroscopic form or morphology of organisms is encoded in their DNA. Nor is there any evidence that viable large-scale changes in morphology can be produced by DNA mutations.

Secondly, Denton says nothing about how this "evolutionary program" is actually going to be stored and expressed over time. Indeed it's difficult even to imagine how that would work.

Nelson: Could we say that one cannot pack a blue whale into the genome of an archaebacterium?

Wells: Sure. In fact, you can't even pack an archaebacterium into a blue whale. Anyway, to sum up, I would say Yes to the first six chapters of *Nature's Destiny*, and a skeptical No to most of the rest. I'm glad Denton wrote the book, and think it's worth reading, but he needs to break free of naturalism really to solve the problems at hand.

Nelson: Other summing-up remarks, anyone?

Behe: I thought the book was really terrific. Denton not only extended anthropic arguments right up into biology, but he widened what people will now have to think about when they speculate about the requirements for life.

Johnson: It's a good book, yes, but the bottom-line question for me is whether there is any alternative to Darwinism within the materialistic framework.

Lots of people, including Denton, like to believe that there is, but when one looks closely, there's nothing there. What that means--and I think this is terrifying for many people--is

that if Darwinism turns out to be false, the mainstream scientific culture will lose control over the origins story they've been telling everyone for a long time. If there isn't a materialistic alternative to Darwinism, and if Darwinism is false, then materialism is in real trouble.

Dembski: I see design as directed contingency--meaning some agent choosing and making real *this* outcome, rather than the indefinitely many *other possible* outcomes allowed by the background regularities and chance.That's just not Denton's conception of design, however, so unfortunately he and I part company at a fairly fundamental level. A strong determinism runs through the whole book, and directed contingency washes out in this great forward thrust of necessity, rushing towards its end, which is humanity.

Everything, literally everything, is fine-tuned for human life in particular. But you can't fine-tune a gene sequence. It has to be specified, and I don't think natural laws are capable of doing that. There are profound limits, easily reached, on what natural laws can do for you.

Meyer: I think Michael is one of the most interesting people writing on origins today, and *Nature's Destiny* makes another really valuable contribution to the whole discussion. His extension of the fine-tuning argument to biology and chemistry highlights an aspect of this discussion that has been overlooked to this point, and is very valuable. Neverthless, his reliance upon natural laws to close the gap between the conditions necessary for life and the set of conditions sufficient for life lacks, from my point of view, both empirical and information theoretic support. In fact, it seems to run counter to some of Michael's own insights about the "problem of emergence" which he expressed in his first book and articles back in the late 1980s. As I mentioned, I found those insights very persuasive personally.

Nelson: Well, thanks everyone for your reflections.