S & CB (2003), **15**, 117–140 0954–4194

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Are Bacterial Flagella Intelligently Designed? Reflections on the Rhetoric of the Modern ID Movement

The modern Intelligent Design movement argues that it can point to specific biological systems that exhibit what ID's chief theorist William A. Dembski calls 'specified complexity'. Furthermore, Dembski claims to have demonstrated that natural causation is unable to generate this specified complexity and that the assembling of these biological systems must, therefore, have required the aid of a non-natural action called 'intelligent design'. In his book, No Free Lunch, Dembski presents the bacterial flagellum as the premier example of a biological system that, because he judges it to be both complex and specified, must have been actualised by the form-conferring action of an unembodied intelligent agent. In this essay we shall challenge Dembski's rhetorical strategy and argue that he has failed to demonstrate the need for non-natural action to assemble the bacterial flagellum.

Key-Words: Intelligent Design; bacterial flagellum; Darwinism

A Snapshot of ID's Cultural Context

Religiously motivated opposition to scientific theories, especially to theories concerning biotic evolution, is not a new phenomenon. Nonetheless, both the *forms* of opposition and the *labels* devised to name the opposing viewpoints do change over time.

Young-earth special creationism, for instance, has blossomed in the last century or two and is rooted in the conviction that the first three chapters of Genesis constitute a concise chronicle of divine creative acts. Read as a chronicle, the text appears to posit that over a period of six 24-hour days God conferred form on the varied materials to which God gave being at the beginning of time, approximately 6,000 years ago. From that viewpoint, biological evolution was *unnecessary* because each basic kind of living creature was given its form by an independent form-conferring act of the Creator. Furthermore, evolution is generally judged by young-earth creationists to be *impossible* as well, either because matter was never given the requisite capabilities to organise into living forms, or because of insufficient time to do so. *Old-earth special creationism* accepts the scientifically-derived chronology of cosmic history, but retains a commitment to the necessity of special creation and the impossibility of biological evolution.

In place of the term *special* creation (originally drawn from the idea that each *species* – or biblical 'kind' – was independently actualised by a new creative act) I find it convenient to substitute the term *episodic* creationism to draw attention to the modern distinction between two contrasting ways of envisioning the formation of new species: 1) by *occasional episodes* of form-conferring divine intervention, and 2) by the *continuous action* of natural processes.

The way in which episodic creationists present their beliefs varies with context. Within their own religious communities, they are free to argue their cases by appeal to the Bible or to theological commitments. But efforts to get episodic creationism into the public (state-supported) school science classroom required the adoption of a different strategy. An approach called *scientific creationism* was formulated without reference to its religious roots and was intended to function as a *scientific* alternative to biological evolution.

Judged on its scientific merit, however, scientific creationism is generally considered to be a dismal failure. This failure, combined with other considerations, has led most episodic creationists to abandon their call to present scientific creationism in the public school science classroom as an alternative to evolutionary theory.

But it is important to realise that the fundamental religious concerns that originally led to the scientific creationist movement remain undiminished. There are still large numbers of parents, especially in North America, who find the teaching of evolution to be religiously offensive. Whether the public school intends it or not, teaching biological evolution without offering some creationism-like alternative is taken by many religiously devout parents to be a violation of the religious neutrality that the state is required to maintain. To parents who are committed to episodic creationism of any sort, it appears as if the public school is promoting the religion of the enemy – often designated *Darwinism*.

These parents have been heartened over the last decade by the growing visibility and political vigour of a relatively new movement that calls its viewpoint 'Intelligent Design' (ID). Its beginning is best marked, I believe, with the publication of the book, *Darwin on Trial*, by Berkeley law professor Phillip E. Johnson.[1] In that popular book Johnson decried the way in which, in his judgment, the preachers of Darwinism had come to dominate the secular educational system by insisting that biological evolution be taught as an established fact. By Johnson's measure, Darwinism was popular not because it was substantiated by the weight of empirical evidence, but rather because it functioned to promote the naturalistic worldview of an entrenched scientific establishment.

I believe the next major advance for the growing ID movement was the pub-

1 Phillip E. Johnson, *Darwin On Trial* (Downers Grove, Ill: InterVarsity Press, 1991).

lication of the book, *Darwin's Black Box,* by biochemist Michael J. Behe.[2] Behe called attention to a number of specific biological systems and biotic structures that struck him as exhibiting a quality – he called it *irreducible complexity* – so remarkable that it could not possibly be the outcome of unguided natural processes alone. Therefore, argued Behe, these structures must have been *intelligently designed*.

Meanwhile, William A. Dembski, trained in philosophy, mathematics and theology, was working on a theoretical strategy that, in his judgment, placed the full analytical power of formal logic, mathematics and information theory on the side of the new ID movement. His recent work will be the focus of our attention in this essay.

The Core of Dembski's Case for ID

In his latest book, *No Free Lunch*, Dembski argues at length that there are natural objects in the world that a) can be unambiguously identified as objects that could not be the outcome of *unguided natural processes* alone, and b) must therefore be the products of *intelligent design*.[3] Such objects are recognisable, says Dembski, because they exhibit the empirically detectable quality he calls *specified complexity*. And some form of non-natural action is necessary because, he argues, unguided natural processes are inherently incapable of generating specified complexity.

In the cultural context of the predominantly North American creation-evolution debate, the natural objects of greatest interest here are biological systems. Dembski's favoured example is the bacterial flagellum, a quite remarkable molecular machine that functions as a propeller for some bacteria, such as E. coli. Now, if there are biological systems that – because they exhibit specified complexity – could *not* have been actualised by natural processes alone, then, argues Dembski, some unembodied intelligent agent must have done something to bring about this naturally impossible outcome. A non-natural action called *intelligent design* must have made possible what nature, unguided by any interactive intelligence, was wholly incapable of doing. That is Dembski's core claim – the claim on which the ID movement either stands or falls.

The Role of the Bacterial Flagellum

The natural sciences concern themselves with a vast diversity of physical, chemical and biological processes that transform some system of interest from

2 Michael J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: The Free Press, 1996).
3 William A. Dembski, *No Free Lunch: Why Specified Complexity Cannot Be Purchased Without Intelligence* (Lanham, MD: Rowman & Littlefield Publishers, Inc., 2002). Future references to this work will be designated simply as *NFL*, p. xyz.

an initial state (i) to a final state (f). Evolutionary biology, for example, deals at length with the processes by which organisms, employing their own functional and transformational capabilities and interacting with both their physical and ecological environments, change in the course of time.

The vast majority of Dembski's argumentation in *No Free Lunch* focuses the reader's attention on his particular concept of the way in which these transformational processes might be limited and constrained by the logical and mathematical requirements of information theory. In Dembski's judgment, the scientific community has been lax in its dealing with these limitations and constraints, especially as they apply to the Darwinian mechanism for evolution. By presuming that all of the transformations of interest to evolutionary biology can be accomplished by purely natural processes, the scientific community has failed, in Dembski's judgment, to give due consideration to the limitations of natural causation and the consequent necessity for supplemental action by a non-natural intelligent agent.

Sometimes, however, Dembski's purely theoretical argumentation regarding these issues seems abstruse and esoteric, far removed from the real life things to which scientific theories are supposed to apply. Concrete illustrations then become essential. In my experience, the key to understanding the character or quality of Dembski's abstract theories is to see how he applies them to specific biological systems. That's where the case of the bacterial flagellum comes into play.

In Dembski's judgment, a straightforward application of his 'design-theoretic reasoning' will clearly demonstrate the need for designer action. 'Design-theoretic explanations are concerned with determining whether some particular event, object, or structure exhibits clear marks of intelligence and can thus be legitimately ascribed to design.'[4] Focusing on the arena of biotic evolution, Dembski believes that he is now in a position to demonstrate convincingly that 'transforming a biological system that does not exhibit an instance of specified complexity (say a bacterium without a flagellum) into one that does (say a bacterium with a flagellum) cannot be accomplished by purely natural means but also requires intelligence'.[5] This is the specific claim that we will examine later in this paper.[6] But first we must acquaint ourselves with the ID movement's agenda and rhetorical strategies.

4 *NFL*, p. 355.

5 *NFL*, pp. 331-332.

6 This essay focuses on the ID movement's principal scientific claim and the rhetorical strategies employed to support it. I have also expressed concern for some of the religious and theological implications of ID's concept of divine creative action. For examples of this critique, see 'Intelligent Design: A Celebration of Gifts Withheld?' published as a chapter in the book, *Darwinism Defeated? The Johnson-Lamoureux Debate on Biological Origins*, Denis O. Lamoureux, Phillip E. Johnson, et al. (Vancouver: Regent College Publishing, 1999); 'Science & Christianity as Partners in Theorizing', published as a chapter in the book, *Science & Christianity: Four Views*, Richard F. Carlson, ed. (Downers Grove, IL: InterVarsity Press, 2000); 'The Creation: Intelligently Designed or Optimally Equipped?' published in the journal *Theology Today,* October, 1998, pp. 344-364; and 'Does Intelligent Design Have a Chance?' published in the journal *Zygon*, Vol 34, No. 4, December, 1999, pp. 667-675.

ID's Goal: The Defeat of Naturalism

In large part, the ID movement is a reaction to its leaders' perception that the worldview of *naturalism* has effectively dominated the worlds of higher education and professional science, and that it is now providing the religious framework for the pre-college public educational system as well. *The ID movement is committed to the defeat of naturalism.* But naturalism comes in many different versions that must, I believe, be carefully distinguished from one another. I find the following distinctions to be essential.

(1) I use the term maximal naturalism to denote the comprehensive worldview built on the premise that Nature is all there is – there is no other form of being, no God or gods – and that there is no ultimate purpose in its existence, character, or historical development.[7] This point of view could also be identified by such labels as materialism (the material/physical world is all there is) or atheism (there is no transcendent God as envisioned by any of the theistic religions).

(2) I use the term minimal naturalism to denote the family of worldviews that reject the idea of supernatural action by any deity. All actions (processes and events) in the universe are presumed to fall entirely in the category of natural actions – actions performed by members of the natural world in ways that are wholly consistent with their own character and capabilities. Although the existence of God, or gods, or purpose is neither affirmed nor denied by minimal naturalism, the idea that any divine being would act supernaturally – that is, coercively overpowering or superceding the natural actions of members of the universe, thereby interrupting the flow of natural phenomena – is rejected.

(3) The term methodological naturalism is often employed to denote the idea that the natural sciences have the competence to investigate natural actions alone and must remain agnostic with regard to any form of divine action.

(4) Naturalistic theism builds its worldview on the premise that there is a God who acts purposefully and effectively in the world, but this divine action is always persuasive and never coercive. In contrast to the several forms of supernaturalistic theism, naturalistic theism rejects coercive supernatural intervention as something that would violate the essential natures of God, the world, and the God-world relationship.

The ID movement, we noted, is committed to the defeat of 'naturalism'. But toward which form of naturalism does it aim its rhetorical guns? There may be some variation in the ID literature, but the consensus seems to be that it does

7 I am indebted to David Ray Griffin for the terminology of *maximal naturalism* and *minimal naturalism* and the way in which this distinction proves helpful in discussions of this sort. See his book, *Religion and Scientific Naturalism: Overcoming the Conflicts* (Albany: SUNY Press, 2000), for further development of this terminology and its application to the relationship of science and religion.

not really matter very much. In the judgment of most ID proponents, the distinctions outlined above are effectively meaningless because all of these versions of naturalism reject one of the fundamental tenets of the ID movement, viz., that the non-natural action called *intelligent design* is *empirically detectable*. In Dembski's words, 'Design is detectable; we do in fact detect it; we have reliable methods for detecting it … As I have argued throughout this book, design is common, rational, and objectifiable.'[8] That being the claim, then each and every one of the forms of naturalism listed above – because they uniformly reject the empirical detectability of divine action – is the target for defeat. To the ID movement, to be a God who is not empirically detectable is to be a dispensable God. Any God whose actions are not empirically detectable would be of no value in defeating naturalism. Naturalism would always be able to say, in effect, 'A God who can never do anything that makes a difference, and of whom we can have no reliable knowledge, is of no importance to us.'[9]

Doing What Comes Naturally

The ID movement has laboured vigorously to formulate a way to determine how things came to be *actualised* (assembled, arranged, organised, constructed) in the course of time. In contrast to theology's concern – in its *doctrine* of creation – for how any universe came to have its being (its existence and/or its particular character) in the first place, the ID movement is concerned with portions of the universe's *formational history*. In Dembski's words, 'Design is fundamentally concerned with arrangements of pre-existing stuff that signify intelligence.'[10] When looking at some *natural object* (any object not crafted by human or animal action, usually some organism or part of an organism), the pivotal question for ID advocates is: Could this object have been actualised by means of *natural processes* (or *natural causes*) alone?[11]

Purely natural processes are those that can be fully accounted for by the actions and interactions of the material substances of which the object and its environment are composed. These are the processes that the natural sciences are equipped to describe in terms of the *empirically known mechani*sms by which atoms, molecules, cells and organisms act, interact, organise or transform themselves. These are often designated in ID literature as *unguided natural processes* to distinguish them from other processes in which some agent (like ID's intelligent designer) intentionally participates (actively 'guides' them) to bring about an outcome distinctly different from what would otherwise have happened naturally.

8 *NFL*, p. 367.
9 Phillip E. Johnson, *Darwin on Trial* (Downers Grove, IL: InterVarsity Press, 1991), p. 115.
10 *NFL*, p. 372n4.
11 Dembski's references to *natural* objects that required some form of *non-natural* action for their formation strike me as awkward. If their actualisation required non-natural action, how can they still be categorised as 'natural' objects?

In ID literature all natural processes or causes are presumed to fall into one of three causal categories: 1) chance, 2) necessity, or 3) the joint action of chance and necessity. Natural objects or events that are the outcome of *pure chance* are products of wholly *random* phenomena (a fair coin-flipping exercise, for example) with no patterning influences at work, and can best be described in purely statistical terms. Natural objects or events that are the products of *necessity* are the outcome of *deterministic natural laws* in which contingency and chance play no effective roles (as in the orbital motion of planets, for example). Most natural objects, however, are the outcome of the joint action of *both chance and necessity*, with randomness, contingency and deterministic laws each playing some significant role.

For the purposes of his 'design-theoretic' analysis, Dembski prefers to treat all three categories at once under the rubric of *stochastic processes,* a concept that allows for variable contributions of both chance and necessity – from pure randomness to full determinism, and all variations between – in one mathematically convenient formalism. Although the unwary reader might easily be confused, Dembski usually designates this full spectrum of causal possibilities with the label 'chance'. Throughout most of *No Free Lunch,* the terms '*chance hypothesis*' and '*chance explanation*' do not refer to chance (random events or processes) alone, but must be taken to mean '*all hypotheses, postulates and theories concerning the natural causation of events*'.

Darwinism = Evolution + Maximal Naturalism

Proponents of ID are not in full agreement in their evaluation of the basic vision of *biological evolution*. Some ID advocates are willing to accept a limited amount of variation and selection but nonetheless balk at the idea that all life forms are related by *common ancestry*. Evolution limited to small changes (microevolution) is often tolerated, but the idea of uninterrupted genealogical continuity (macroevolution) among all life forms over billions of years of earth-history is rejected. Phillip Johnson, for instance, sees the common ancestry thesis as the foundation of *Darwinism* – the view of life's formational history that he vigorously rejects.

> When we posit that the discontinuous groups of the living world were united in the remote past in the bodies of common ancestors, we are implying a great deal about the process by which the ancestors took on new shapes and developed new organs … There may be arguments about the details, but all the basic elements of Darwinism are implied in the concept of ancestral descent.[12]

There are other ID advocates, however, who express a willingness to accept the common ancestry thesis as a real possibility, but insist that the changes

12 *Darwin on Trial*, p. 150.

that took place over time required more than natural processes alone. Michael Behe, for instance, says

> I find the idea of common descent (that all organisms share a common ancestor) fairly convincing, and have no particular reason to doubt it … Although Darwin's mechanism – natural selection working on variation – might explain many things, however, I do not believe it explains molecular life.[13]

And Dembski comments that

> …intelligent design is not a form of anti-evolutionism. [On the contrary, intelligent design is] fully compatible with large-scale evolution over the course of natural history, all the way up to what biologists refer to as 'common descent'.[14]
>
> But – and this is the place where an ID-based curriculum will differ from how biological evolution is currently taught – intelligent design is not willing to accept common descent as a consequence of the Darwinian mechanism. The Darwinian mechanism claims the power to transform a single organism (known as the last common ancestor) into the full diversity of life that we see both around us and in the fossil record. If intelligent design is correct, then the Darwinian mechanism of natural selection and random variation lacks that power.[15]

What all advocates of ID do seem to agree on is their judgment that *Darwinism* is impossible because the *Darwinian mechanism* is inadequate to accomplish the large-scale transformations envisioned by nearly every professional biologist today. But a reader of ID literature must pay careful attention to the varied operative meanings that these key terms are given. At minimum, *Darwinism* denotes the concepts of large-scale biological evolution and common descent as consequences of unguided natural processes. But there is usually far more meaning packed into the term as it is employed rhetorically in ID literature. 'Darwinism' is commonly employed to characterise biological evolution as a way of accounting for the formational history of life that is both 'thoroughly naturalistic' and 'nonteleological'. Now, if the term 'thoroughly naturalistic' entailed only *minimal* or *methodological* naturalism, then a number of theistic worldviews could accommodate it. But if 'thoroughly naturalistic' Darwinism is presumed to entail *maximal* naturalism, then Darwinism effectively becomes a member of the family of atheistic worldviews. This, I believe, is the rhetorical impact most commonly intended in the literature of the ID movement, especially when the reader is offered the binary choice – *either* Darwinism *or* design.

13 Michael J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: The Free Press, 1996), p. 5.
14 *NFL*, p. 314.
15 NFL, pp. 314-315.

Similar concerns must be raised when Darwinism is referred to as a 'nonteleological' theory – a concept that excludes reference to goals, purposes or intentions. If this exclusion refers only to individual events or to low level natural processes in isolation from the larger context, that would be consistent with minimal naturalism and open to various forms of theism. But if the characterisation of 'nonteleological' entails the rejection of purpose or intention at *all* levels of consideration, then 'Darwinism' is once again functioning effectively as a substitute label for 'maximal naturalism'.

The Darwinian Mechanism

The term 'Darwinian mechanism' refers, of course, to the menu of *relevant natural processes* that are presumed by the vast majority of biologists to make biological evolution and common descent possible. Here the key question is: In the judgment of ID advocates, what are the 'relevant' natural processes that belong on this list? At minimum, the Darwinian mechanism menu includes genetic *variation* and natural *selection*. As Dembski expresses it, 'The Darwinian mechanism consists of random variation, which provides the raw material for Darwinian evolution, and natural selection, which sifts that material.'[16]

But there may be many more categories of natural processes that have contributed to the success of biological evolution over life's formational history. Would ID proponents place all of these in the category of Darwinian mechanism? Evidently not. For instance, in their evaluation of the proposition that certain 'irreducibly complex' biological structures like bacterial flagella were formed by this mechanism, both Behe and Dembski limit their evaluation to *gradual* processes only, processes that bring about only minuscule functional improvements (sometimes narrowly constrained to a single function) from generation to generation. According to Behe, for instance, 'The key question is this: How could complex biochemical systems be gradually produced?'[17] And in Behe's book, *Darwin's Black Box*, the index listing for 'Darwinian evolution' includes the parenthesised clarification '(gradualism)'.

In *No Free Lunch*, Dembski tells us that 'The problem, then, is to coordinate the gradual Darwinian evolution of an organism with the emergence of an irreducibly complex system that the organism now houses but did not always possess.'[18] Those transformational processes or events that fall outside a strict gradualism appear to be set aside as natural processes that are not relevant to ID's evaluation of the Darwinian mechanism. 'Ideas like coordinated macromutations, lateral gene transfer, set-aside cells, and punctuated saltational events are thoroughly non-Darwinian.'[19] But the real question, it seems to me,

16 *NFL*, p. 286.
17 *Darwin's Black Box*, p. 34.
18 *NFL*, p. 286.
19 *NFL*, p. 287.

is this: Whether or not these and other such events are considered to fall within the bounds of a strict gradualist definition of the 'Darwinian mechanism', *are they relevant to the formational history of life on earth*?

Another restriction on the menu of *relevant* natural processes considered by Dembski as legitimate contributors to the Darwinian mechanism arises from his requirement that scientific explanations regarding evolutionary processes must be *causally specific*. In Dembski's words, 'Causal specificity means specifying a [natural] cause sufficient to account for the effect in question.'[20] 'Lack of causal specificity leaves one without the means to judge whether a transformation can or cannot be effected.'[21]

Full causal specificity is, of course, the goal of all scientific explanations, but it is often very difficult to achieve, especially in the reconstruction of life's formational history. That's just a fact of life in evolutionary biology, as well as in many other areas of science. What should biology then do? Abandon its search for natural causes? Open the door to hypotheses regarding non-natural causation? Posit the possibility of occasional form-conferring interventions by an unembodied intelligent agent? Yes, says Dembski. In effect, that is the ID proposal. After noting that science – 'when biased by naturalism' – tends to restrict its search for explanations to purely natural causes, Dembski argues: 'But in the absence of causal specificity, there is no reason to let naturalism place such restrictions on our scientific reasoning.'[22]

I suppose that one could grant the possibility that this last point is technically correct, but one could equally well argue that there *are* good reasons – scientific, philosophical and theological – why most of us *do* find positing the sufficiency of natural causes to be warranted. Regardless of that, however, Dembski introduces a serious problem into his analysis when he takes full causal specificity to be a requirement for natural causes to be relevant contributions to the Darwinian mechanism. Many scientific hypotheses regarding the manner in which various transformational processes may have contributed to the actualisation of some new biotic structure might fall short of full causal specificity – even though they may be highly plausible applications of mechanisms that are at least partially understood. When that is the case, the ID approach tends to denigrate them as nothing more than 'just-so stories' and to remove them from further consideration.[23] Only those mechanisms that are now *fully understood*, it seems, can be placed on the menu of relevant natural processes contributing to the Darwinian mechanism.

As I see it, the net effect of this requirement that only *causally specific expla-*

20 *NFL*, p. 240.
21 *NFL*, p. 242.
22 *NFL*, p. 244
23 According to Dembski, 'Darwinian just-so stories have no more scientific content than Rudyard Kipling's original just-so stories about how the elephant got its trunk or the giraffe its neck.' *NFL*, p. 368.

nations count toward *relevant scientific accounts* of how certain biotic structures got actualised throws the door wide open to false positive claims regarding the need for non-natural explanations. No doubt there are now numerous biotic structures for which science is unable to formulate causally specific (detailed and complete) accounts of their actualisation. In the absence of full causal specificity (a quality, incidentally, that ID does not demand of its own explanations) the ID movement does indeed have opportunity to posit its non-natural, intelligent design explanations as logically permitted alternatives. However, each time a new causally specific scientific explanation for one of these biotic structures is developed, the ID explanation for its actualisation immediately becomes superfluous.[24] This is essentially the same situation encountered in the familiar God-of-the-gaps strategy.

What Does It Mean to Be 'Intelligently Designed'?

Stated as succinctly as possible, the core scientific claim of the ID movement is, in effect: 'We have firm empirical evidence that some biotic system X could not possibly have been actualised (at least not for the very first time) by purely natural processes; therefore X must have been *intelligently designed*.' In order to evaluate that claim, two questions must be asked: (1) On what evidence and reasoning do ID advocates base their claim that X could not have been actualised by natural processes alone? (2) What do ID advocates actually mean when they say 'X was intelligently designed'? Question (1) will be dealt with in our analysis of Dembski's claim that the bacterial flagellum (a specific example of an X) could not have formed naturally. Question (2) will now be the focus of our attention. Presuming that intelligent design is some form of action, what kind of *action*? And, action by what sort of *agent*?

We speak often today of things that have been designed. Cars are designed; clothing is designed; buildings are designed. Suppose, then, we were to walk into the headquarters of a car manufacturer and ask to observe the process of cars being designed. Would we be taken to the assembly line to see cars being put together by human hands and mechanical robots? No, we would be taken to the 'design centre' where we would see people working with their minds (augmented, of course, by computers and various means of modelling what their minds conceive) to conceptualise new cars of various styles to achieve the intentions of the manufacturer in the marketplace. In contemporary parlance, *the action of design is performed by a mind, intentionally conceptualising something for the accomplishment of a purpose.*

24 See *NFL*, p. 364, for Dembski's acknowledgment of this. 'Even if the Darwinian mechanism could be shown to do all of the design work for which design theorists want to invoke intelligent causation (say for the bacterial flagellum and systems like it) a design-theoretic framework would not destroy any valid findings of science. To be sure, design would then become a largely superfluous component of this framework…'

This *mind-like* action of *designing* is clearly distinguishable from the *hand-like* action of *actualising* (assembling, arranging, constructing) what had first been designed. On a tour of a car manufacturing facility, for instance, we would have no difficulty in distinguishing the mental work done at the design centre from the manual work done on the assembly line.

But in the history of thought about how living things got to be the way they now are, the word 'design' as the name of an action has often had a different meaning. Two centuries ago William Paley, for instance, spoke eloquently of things like the eye as having been designed, much as he would say that a pocket-watch was designed. Clearly the several parts of a watch work efficiently and harmoniously to accomplish the task of keeping and displaying the time. Looking at a watch, we would say without hesitation that such a timepiece had been designed by a watchmaker. Without doubt, the watchmaker had used his mind to conceptualise the workings of the watch for the purpose of keeping and displaying the time.

But mind-action alone does not produce a working watch. The watch must also be *actualised* by hand-action. As an artisan, the watchmaker must not only conceptualise the configuration of gears and dials that comprise a watch; he must also *form* the various parts and *assemble* them into an actual working mechanism. In the context of eighteenth century natural theology, to say that something had been designed was to say that it had been *both* purposefully *conceptualised* (by mind-like action) *and* skilfully *crafted* (formed and/or assembled by hand-like action). This traditional meaning of design action was based on the artisan metaphor. One person, the artisan, performed two actions – mindfully *conceptualising* some artefact and manually *crafting* what had first been planned.

What does it *now* mean to be 'intelligently designed"? Given ID's almost exclusive emphasis on the question of how things came to be structured as they now are, and given ID's repeated emphasis on the presumed inadequacy of natural processes to actualise these structures, it is clear that the primary meaning of 'X was intelligently designed' is that 'X was actualised by the form-conferring action of some non-natural agent called an *intelligent designer'*. As an action, intelligent design entails both the mind-action of conceptualisation and the hand-like action of constructing or assembling some functional structure, *with a very strong emphasis on 'design' as the means of actualisation.*

What sort of agents are capable of performing the proposed action of intelligent design? First, of course, they must be *intelligent*, which in this context means *capable of making intentional choices*. Human agents are certainly intelligent in this sense, but one could speak also of choice making by some animals as well. However, as noted above, the intelligent agents of which ID speaks must also be able to *effect* what was first chosen, or to *actualise* what was first conceptualised.

When considering *embodied* intelligent agents, such as humans or animals,

we have no difficulty envisioning how the dual action of conceptualising and actualising might be carried out. Paley's artisan-watchmaker could both conceive of an appropriate mechanical clockwork and then proceed to form the various parts and to assemble them into a functional watch. However, when ID advocates speak of biotic systems in nature as the products of intelligent design action they are proposing action by an agent of an entirely different sort – an *umembodied* intelligent agent who can both purposefully conceptualise something and actualise that conception in some material/physical structure. For the moment, suppose we set aside the matter of how an unembodied intelligent agent might engage in the mind-like action of conceptualising something, say a bacterial flagellum. Philosophers and theologians have long presumed it reasonable to posit and reflect on such mind-like action.

The more difficult problem, it seems to me, arises when ID advocates posit an unembodied intelligent agent acting in such a way as to effect or modify some physical/material structure. How, for instance, might an unembodied intelligent agent act on a bacterium with no flagellum to actualise a flagellum where none had been before? How does *intelligence* (now meaning the action of an unembodied, choice-making agent) accomplish that? Does the unembodied agent somehow *force* the various atomic and molecular components into their proper configuration? How does a *non-physical* agent exert *physical* forces?

Dembski freely admits that he cannot offer any causally specific model for this action, but he also argues that this should not be seen as a shortcoming of the ID proposal. After all, '*Intelligent design is not a mechanistic theory*.'[25] Yes, but earlier Dembski had suggested that a more substantial proposal regarding a model for designer action might be forthcoming. 'A design inference therefore does not avoid the problem of how a designing intelligence might have produced an object, It simply makes it a separate problem.'[26] It seems, however, that this particular 'separate problem' has been permanently placed in the 'solution impossible' file. Dembski's disclaimer that modelling intelligent design action is both unnecessary and at the same time a 'separate problem' seems thin and facile.

But Dembski makes another disclaimer that seems even more difficult to maintain or defend: *to posit intelligent design action is not the same as positing a miracle.* In his effort to 'get around the usual charge of miracles', as Dembski aptly puts it, he defines a miracle in a way designed (in the sense of *mindfully intended*) to avoid the problem. 'Miracles typically connote a violation or suspension or overriding of natural laws.'[27] That is, where a natural cause was set to make X happen, Y happened instead. A miracle is a form of 'counterfactual substitution'.

25 *NFL*, p. 330.
26 *NFL*, p. 112.
27 *NFL*, p. 326.

According to Dembski, however, intelligent design action does not *necessarily* entail a suspension or overriding of natural laws.

> When humans, for instance, act as [embodied] intelligent agents, there is no reason to think that any natural law is broken. Likewise, should an unembodied designer act to bring about a bacterial flagellum, there is no reason prima facie to suppose that this designer did not act consistently with natural laws. It is, for instance, a logical possibility that the design in the bacterial flagellum was front-loaded into the universe at the Big Bang and subsequently expressed itself in the course of natural history as a miniature outboard motor on the back of *E. coli.*[28]

What does Dembski here mean by 'the design of the bacterial flagellum' that may have been 'front-loaded into the universe at the Big Bang'? In the larger context of Dembski's argument, I am led to conclude that 'design', used as a noun in this instance, here denotes both a plan and a provision – a plan for actualising the flagellum and a provision of all of the initial conditions and formational capabilities needed to ensure that the plan would be carried out in detail. Front-loading a universe for the actualisation of some biotic structure appears to be comparable to providing a computer with both a specific program and all of the computational capabilities needed to ensure that some particular result would be generated.

Elsewhere in *No Free Lunch*, however, Dembski makes it abundantly clear that he is no friend of this 'front-loading' hypothesis. Dembski's Intelligent Designer is one who *interacts* with the universe *in the course of time*. The design action posited to actualise the bacterial flagellum, as we shall see, is an action that occurs long after the Big Bang. Furthermore, since Dembski argues vigorously that the assembling of E. coli's flagellum could not have come about naturally, the question is: How could the Intelligent Designer bring about a *naturally impossible outcome* by interacting with a bacterium in the course of time without either a suspension or overriding of natural laws?[29] Natural laws (which entail the probabilities for various outcomes) would have led to the outcome, no flagellum. Instead, a flagellum appeared as the outcome of the Intelligent Designer's action. If that is not a miracle, what is? How can this be anything other than a *supernatural intervention*?

Dembski does attempt an answer to this question.

> The physical world consists of physical stuff, and for a designer to influence

28 *NFL*, p. 326.

29 Dembski could argue here that the natural assembling of the first flagellum is not absolutely impossible, only highly improbable. While that might be technically true, the whole of Dembski's argumentation is dedicated to demonstrating that non-natural action was an *essential element* in the assembling of the first bacterial flagellum. In those circumstances, the technical distinction between 'naturally impossible' and 'possible but so astoundingly improbable as to conclusively preclude natural formation' strikes me as the rhetorical equivalent of attempting to hang a 500-pound painting on the wall with a tailor's pin.

> the arrangement of physical stuff seems to require that the designer intervene in, meddle with, or in some way coerce this physical stuff[30]… But what if the designer is not in the business of moving particles but of imparting information? In that case nature moves its own particles, but an intelligence nonetheless guides the arrangement.[31]

In response to concerns that I have often raised about the character of design as an action, Dembski says, 'Van Till asks whether the design that design theorists claim to find in natural systems is strictly mind-like … or also hand-like … But Van Till has omitted a third option, namely, that design can also be word-like (i.e., imparting information to a receptive medium).'[32]

So, as we try to picture an unembodied intelligent designer adding a flagellum to E. coli, we must envision the bacterial cell as a 'receptive medium' to which *the designer, in word-like fashion, imparts information* concerning the process of assembling a rotary propulsion system. Might we find it difficult to understand how this designer-speech works without entailing a suspension or overriding of natural processes? Yes, of course we would, but difficulty in understanding is not unusual in science, suggests Dembski. 'We do not *understand* how quantum mechanics works, but we *know* that it works. So too, we may not *understand* how an unembodied designer imparts specified complexity into the world, but we can *know* that such a designer imparts specified complexity into the world.'[33] I must confess that I do not have such knowledge, but let us move on to evaluate Dembski's claim that he does.

The Signs of Design

How would we come to know that something was intelligently designed? It's very straightforward, says Dembski.

> There does in fact exist a rigorous criterion for discriminating intelligently caused from unintelligently caused objects … I call it the *complexity-specification criterion.* When intelligent agents act, they leave behind a characteristic trademark or signature – what I define as specified complexity. The complexity-specification criterion detects design by identifying this trademark of designed objects.[34]

> Whenever we infer design we must establish three things: *contingency, complexity,* and *specification.*[35]

An object/event is said to be *contingent* if, while it is fully consistent with

30 *NFL*, p. 334.
31 *NFL*, p. 335.
32 *NFL*, p. 343
33 *NFL*, p. 343
34 *NFL*, p. 6.
35 *NFL*, p. 8.

natural laws, it is not wholly determined by them and represents only one outcome among several possible outcomes of natural processes. *Complexity* is related inversely to probability. Highly complex objects have a low probability of being actualised naturally. Dembski looks for objects whose probability of actualisation by natural means is less than what he calls the 'universal probability bound', which has the value 10^{-150}. For some event/object to be *specified* it must exhibit a distinctive pattern that is *detachable* from the particular event/object itself. A detachable pattern might, for instance, correspond to some independently derivable sequence of numbers or letters that has no necessary connection to the object/event being subjected to the complexity-specification criterion. For example, if SETI (search for extraterrestrial intelligence) researchers received a radio signal representing the first 100 prime numbers they would be justified in concluding that the signal exhibited a detachable pattern that had no necessary relationship to the electromagnetic waves that carried it.

In Dembski's language, if some event/object is *contingent* (not the outcome of any deterministic natural law), and *sufficiently complex* (its probability of natural actualisation is less than 10^{-150}), and *specified*, then it exhibits *specified complexity*. The central argument of *No Free Lunch* is that objects/events that exhibit specified complexity cannot be actualised by *natural processes* alone and must, therefore, be the outcome of *intelligent design*, in the sense consistent with the way in which all of the key terms have been defined above.

Establishing the contingency of some event/object is ordinarily a rather simple matter. Establishing complexity and specification, however, is difficult (perhaps impossible), as our case study of the bacterial flagellum will illustrate.

E. coli and its Rotary Propulsion System: Dembski's Flagship Case for Design

Escherichia coli is a species of bacteria commonly found in the human intestinal tract and has been used extensively for studies of molecular genetics. The genome of E. coli consists of about 4.7 million base pairs, representing approximately 4000 genes. The formation, structure and functions of the cell and its component parts are expressions of the information coded in the base pair sequences that comprise the E. coli genome.

Protruding outward from the E. coli cell wall is a hair-like filament made of the protein flagellin. The base of the filament is attached via a bent 'hook' structure to a miniature rotary drive mechanism embedded in the plasma membrane and constructed from several types of protein molecules. This configuration of motor, hook and filament constitutes the flagellum system.

A cutaway sketch of the flagellum, complete with its rotary motor system, appears prominently on the front cover of Dembski's book, *No Free Lunch*. Dembski uses the bacterial flagellum as the principal example of what he con-

siders to be an *intelligently designed* biotic structure.

> On a Darwinian view, a bacterium with a flagellum evolved via the Darwinian selection mechanism from a bacterium without a flagellum. For this mechanism to produce the flagellum, chance modifications have to generate the various proteins that constitute the flagellum and then selection must preserve them, gather them to the right location in the bacterium, and then properly assemble them.[36]

> With regard to a particular biochemical system like the bacterial flagellum, intelligent design asserts that 'No undirected natural process could produce this system.'[37]

In the eyes of design theorists like Behe and Dembski, the bacterial flagellum presents the *Darwinian mechanism* with an insurmountable problem. Employing some of the ID vocabulary that we have already examined, the nature of the problem as they see it can be stated as follows:

1) the bacterial flagellum displays *specified complexity;*

2) specified complexity in biotic systems cannot be generated by *the Darwinian mechanism,* which relies on *chance;*

3) therefore the bacterial flagellum must have been *intelligently designed* – that is, it could have been actualised only with the assistance of form-conferring interventions by an unembodied intelligent agent.

Since Dembski's entire system of design inferences is built on the premise that *specified complexity is demonstrably present but naturally impossible*, let us examine statement 1) more closely.

To say that the bacterial flagellum exhibits specified complexity requires the demonstration that the flagellum is both *complex* and *specified*, where the meaning of each of these two terms must be taken from Dembski's development of the complexity-specification criterion. We shall deal with each of these two requirements individually, beginning with complexity.

Is the Flagellum Complex? General Considerations

According to Dembski, to say that any biotic system X (such as the bacterial flagellum) is *complex* is to say that the probability of its actualisation (its coming to be assembled or constructed as a distinct biotic structure) must be less than the 'universal probability bound', $\alpha = 10^{-150}$; or, to say it more concisely, *X is complex if P(X)* < a.[38]

36 *NFL*, p. 250.
37 *NFL*, p. 272.
38 See *NFL*, pp. 18-22, for a discussion on the universal probability bound and Dembski's employment of it.

Dembski's criterion for complexity is easy to state, but difficult, if not impossible, to apply. The principal difficulty arises when we examine precisely what has to be taken into account when P(X), the probability that X will be actualised, is computed (or estimated). Two considerations lead me to the same conclusion regarding what factors the computation P(X) must take into account.

First, Dembski calls attention to the importance of computing P(X) in the context of all available 'probabilistic resources that describe the number of relevant ways an event might occur'.[39] 'The important question therefore is not What is the probability of the event in question? but rather: What does its probability become after all the relevant probabilistic resources have been factored in?'[40] In the context of applying the complexity-specification criterion, the relevant probability is the probability that X came to be actualised as the outcome of unguided natural processes, whether these are a) pure chance phenomena, b) regularities described by deterministic natural laws, or c) the joint action of chance and regularity. For the sake of convenience, let us use the notation P(X | N) to denote the probability that X will be actualised by the joint action of all relevant natural processes, N. (This 'N' is what Dembski most often means by the term, 'chance hypothesis'.) The complexity requirement can now be stated more clearly as: *X is complex if P(X | N)* < a.

Secondly, when Dembski develops his mathematical system for dealing with the role of natural processes in generating complex specified information (equivalent to specified complexity) he argues that 'stochastic processes (representing nondeterministic natural laws and therefore the combination of chance and necessity) … constitute the most general mathematical formalism' for dealing with both chance and necessity at the same time. 'Natural causes are properly represented by nondeterministic functions (stochastic processes).'[41] Setting aside the question of whether or not natural processes are capable of generating this 'specified complexity', the important consideration for the moment is simply to note that in determining the complexity of some X, *all relevant natural causes* – what Dembski often calls the 'chance hypothesis', or the joint action of both chance and necessity – must be taken into account.

By either route, then, we come to the same conclusion: To determine if X is *complex* (using Dembski's meaning of the term) we need to compute the value of P(X | N), the probability that X could be actualised by the joint action of all relevant natural processes – all *pure chance* opportunities, all *regularities* described by *deterministic* laws, all *contingent* histories influenced by *evolutionary algorithms*, and the like. If this $P(X \mid N) < \alpha$, then Dembski counts X as exhibiting sufficient complexity to proceed with the question regarding its specification.

39 *NFL*, p. 19.
40 *NFL*, p. 21.
41 *NFL*, p. 150.

But there is, of course, an obvious epistemic difficulty here. In no case do we know with certainty *all* relevant natural ways in which some biotic system may have historically come to be actualised. If 'N' represents *all* relevant natural causes, both known and unknown, and if we use a lower case 'n' to designate only those natural causes that are *known* to be relevant, then it is clear that the best we can do is calculate P(X | n), which is most likely to be considerably less than P(X | N).

In some cases this limitation of knowledge might be inconsequential. If, for example, we knew enough to make the calculated value of $P(X \mid n) > \alpha$, then the question of complexity can be settled (X is not complex) without an exhaustive knowledge of all relevant natural processes. But what if our knowledge is inadequate to do the probability calculations? As I see it, the only honest thing to do is say so with candour, and admit that no definitive conclusions can be reached.

One thing we could say, however, is that the more we learn about the self-organisational and transformational feats that can be accomplished by biotic systems, the less likely it will be that the conditions for *complexity* – as Dembski employs this term in relation to *specified complexity* – will be satisfied by any biotic system.[42] For example, in reference to the power of evolutionary algo-

42 In his response (posted 6 Sept., 2002, at www.iscid.org/ubb/ultimatebb.php?ubb=get_topic;f=6;t=000150;p=1) to an earlier version of this paper, Dembski characterised this statement as nothing more than 'wishful thinking'. He argues that I am incorrect in saying that as 'n' (representing those natural causes that are *known* to be relevant to the formation of X) approaches 'N' (representing *all* relevant natural causes, known and unknown) the probability P(X | n) will increase. 'But that's not how probabilities work,' says Dembski. 'With increasing knowledge, the probability may stay the same or even decrease.'

But it is Dembski who is mistaken on this point. In the spirit of Dembski's computations of P(X | n), the only contributions to 'n' that are allowed to contribute are those considered to be computationally 'relevant', which means that there must be a causally specific account that is sufficiently detailed and complete as to allow an actual probability computation. Hypotheses that do not provide the means to compute probabilities cannot contribute to P(X | n). Plausibility arguments, for example, are placed in the category of 'just-so stories' that do not count toward any substantive scientific account of natural processes that might eliminate the need for non-natural 'intelligent design' action. 'Science,' says Dembski, 'must form its conclusions on the basis of available evidence, not on the possibility or promise of future evidence.' Consequently, the discovery of a previously unknown (but now known to be computationally relevant) formational process will necessarily add a *positive* contribution to P(X | n) in place of a null contribution prior to discovery. All probability contributions, as Dembski knows well, are necessarily positive.

Two potential exceptions need to be examined: 1) Could the discovery of a new contribution to 'n' lead to *no change* in P(X | n)? Perhaps, but then it seems to me that it would fall outside of the category of those natural processes that Dembski would consider to be 'relevant' to the formation of X in the first place. That being the case, then the 'no change' possibility is irrelevant to the issue at hand. 2) Could an increase in knowledge of 'n' lead to a *decrease* in P(X | n)? Dembski thinks so, arguing that 'increased knowledge of natural processes may merely drive the probabilities still lower and thus make the complexity even more extreme'. But, since all probability contributions are positive, that could be the case only if P(X | n) had been *incorrectly* computed (by overestimation) in the first place. The 'increased knowledge' that Dembski here refers to is not drawn from the *discovery* of previously unknown processes (which is what I had in mind from the outset) but represents only the *correction* of previously mistaken notions about some process once thought to be sufficiently well understood to perform the computation of P(X | n).

It therefore remains the case that, as a general rule, Dembski's computations of P(X|n) – because they include the

rithms – natural processes that effectively search for increasingly better performance at some task – Dembski acknowledges that 'An evolutionary algorithm acts as a *probability amplifier* … But a probability amplifier is also a *complexity diminisher*.'[43] This is true not only for evolutionary algorithms, but for any natural cause that functions to explore the 'possibility space' of useful biotic systems and to submit novel variations to the test of viability.

On numerous occasions Dembski asserts, in effect, that 'natural causes cannot generate specified complexity'. Given the definition of specified complexity, however, such statements are, at best, only trivially true. They are nothing more than tautological statements. The principal requirement for exhibiting specified complexity is the requirement that some structure/system cannot be (or is highly unlikely to be) actualised by natural causes. The question, however, is: Are there any actual objects that demonstrate this quality? If there are no biotic systems that actually have this Dembski-defined quality of *specified complexity*, then there would be no need to 'generate' it in the first place.

But what about the bacterial flagellum in particular? Dembski is quite confident that he has demonstrated that it is more than sufficiently complex (difficult to assemble naturally) to satisfy the complexity portion of the complexity-specification criterion. How did he do the computation, and what is the standing of his conclusion?

Is the Flagellum Complex? Computing the Crucial Probability.

Following Behe, Dembski describes the bacterial flagellum as an 'irreducibly complex system that is unattainable by the Darwinian mechanism'.[44] He then seeks 'to show how irreducible complexity is a special case of specified complexity, and … to sketch how one calculates the relevant probabilities to eliminate chance and infer design for such systems. Determining whether an irreducibly complex system exhibits specified complexity involves two things: showing that the system is specified and computing its probability … Specification is never a problem.'[45] We will deal with that glib remark about specification shortly, but our immediate concern is with Dembski's attempt to compute P(flag | N), the probability that E. coli's flagellum was actualised by the joint action of all relevant natural processes.

Curiously, Dembski not only rejects any proposal consistent with the gradu-

positive contributions of only a partial list of the natural processes that may have contributed to the natural formation of X – will constitute an *under*estimation of P(X|N) and thereby open the door to numerous false positive indications of a need for non-natural action to accomplish the formation of some biotic system X. The whole point of this portion of my essay is simply to point out that this vulnerability to false positive indications of the need for extra-natural assembly must be candidly acknowledged by advocates of ID and that unqualified claims of having *proved* the incompleteness of natural processes and the consequent need for supplemental designer action are completely out of place.

43 *NFL*, pp. 182-183.

44 *NFL*, p. 288.

45 *NFL*, p. 289.

alism that ID presumes to be an essential feature of the Darwinian mechanism, he also effectively ignores the fundamental role that genes play in providing the instructions for the development of cellular structures. Instead, Dembski simply asserts that the probability in question must be computed by treating the bacterial flagellum as a chance-assembled *discrete combinatorial object*. A discrete combinatorial object (dco) is an object that is composed of particular kinds of building blocks that must first be gathered into one location and then configured in a particular arrangement to form the complete object. According to Dembski, the probability that such an object would form naturally is the product of three distinct probability factors. P(dco) = P(orig) x P(local) x P(config) where

P(orig) = the origination probability = the probability that the requisite building blocks for the structure in question will originate, by chance,

P(local) = the localisation probability = the chance probability of localising these building blocks in one place once they become available, and

P(config) = the configuration probability = the chance probability of configuring the building blocks into the particular structure once they are localised.

Dembski repeatedly refers to these probability factors as probabilities that some process (origination, localisation, or configuration) will successfully occur 'by chance'. Remembering that in ID literature the term 'by chance' can mean either 'by pure chance' or 'by all relevant natural processes', which of these meanings is here intended? In context, and given Dembski's method of computation, it would appear that the 'pure chance' meaning is the primary meaning here intended.

So, then, we are asked to imagine a bacterial flagellum arising from the pure chance gathering of approximately 50 of the right kinds of proteins (and in the correct proportions) at some spot in the vicinity of the cell wall and plasma membrane of E. coli and then, again by chance, happening to configure themselves into a functioning rotary propulsion system for this bacterial cell.

Not surprisingly, Dembski's computations and estimations of the three probability factors lead him firmly to the expected conclusion: Considered as a *discrete combinatorial object* that must self-assemble from the chance localisation of the requisite, chance-assembled molecular components, the probability of a flagellum assembling itself and attaching itself to the cell membrane of E. coli is exceedingly small in comparison to the universal probability bound.

Note carefully, however, what Dembski has actually done with his probability computation. By his own definition of complexity, the probability value he needs is P(flag | N), the probability that the flagellum could form by the joint action of *all relevant* natural means. However, given the epistemic limitation we noted earlier, the best he could possibly do would be to compute P(flag | n), the probability that the flagellum could form by the joint action of *known* nat-

ural means. But this is *not* what he actually computed. What Dembski computed instead is P(flag | dco), the probability that the flagellum could form by *pure chance alone* as a *discrete combinatorial object*.

But, of course, *no biologist has ever taken the bacterial flagellum to be a structure that self-assembled in the manner described by Dembski.* Dembski has not defeated any actual biological proposition. E. coli bacteria possess flagella, not because flagella self-assemble and self-attach to the cell membrane, but because the genome of E. coli came to include in its genetic library the coded instructions for growing the flagellar propulsion system. That being the case, the question that Dembski needed to deal with was not, Could the flagellum self-assemble as a discrete combinatorial object? but rather, Could that portion of the E. coli genome that codes for the production of a flagellum have come about by natural means?

Stating the question in this manner, however, places Dembski in a difficult and awkward position. The awkward element is simply that he failed to deal with this fundamental question in any substantive way. By focusing his energies on an attempt to compute the mathematical probability that a bacterial flagellum would self-assemble from a highly improbable environment of specialised proteins, Dembski effectively chose to ignore the role of genetics in the formation of biotic systems. Given the relevance of genetics to evolution, that is an astounding choice. The consequence of that choice is that the probability value he computed has no biological relevance to the question of how flagella of E. coli bacteria were first actualised.

Is the Flagellum Specified?

If the *complexity* of the bacterial flagellum – where complexity is defined by Dembski's own unorthodox criterion – has not been successfully demonstrated, then the matter of its *specification* could, perhaps, be set aside as no longer relevant. Nonetheless, let us look briefly at Dembski's development of this portion of his argument.

Recall that for some event/object to be *specified* it must exhibit a distinctive pattern that is *detachable* from the particular event/object itself. A detachable pattern is one that could have been derived by wholly independent means. In several places in *No Free Lunch*, Dembski goes to considerable lengths to state the requirements that specification and detachability must satisfy in the careful language of logic, set theory and the like. However, when it comes time for Dembski to support his conviction that the bacterial flagellum is specified, the procedure becomes considerably more casual, almost facile. Speaking on the specification of biological systems in general, Dembski simply asserts, 'Biological specification always refers to function. An organism is a functional system comprising many functional subsystems. In virtue of their function, these systems embody patterns that are objectively given and can be identified independently of the systems that embody them. Hence these systems are specified

in the sense required by the complexity-specification criterion.'[46] In these four brief sentences the foundation of Dembski's entire strategy for certifying the specification of biotic systems is laid.

Addressing the particular question regarding whether the bacterial flagellum is specified, Dembski confidently declares, 'Specification is never a problem. The irreducibly complex systems we consider, particularly in biology, always satisfy independently given functional requirements … For instance, in the case of the bacterial flagellum, humans developed outboard rotary motors well before they figured out that the flagellum was such a machine.[47] The flagellum functions like an outboard rotary motor. The rotary outboard motor pattern represents a functional requirement independent of biological systems. Therefore, concludes Dembski, the flagellum is specified.

But suppose we looked at the pattern, not in the flexible language of biological function, but in the objective arena of structural configuration. Furthermore, where is the question of pattern more relevant than in the genetic code for the flagellum? That being the case, then our search for a detachable pattern should be directed toward the base-pair sequence in E. coli's circular DNA molecule. Surely there is an identifiable pattern there that characterises the genetic coding for the flagellum, right? Right, indeed. But the crucial question is: Is that pattern *detachable* from the event under consideration, *E. coli develops a flagellum*?

The answer to this question is a resounding, No. The pattern in the base-pair sequence associated with this flagellum-actualisation event is unique to that event and to that event alone. The pattern and the event are not independent, but stand in a one-to-one relationship. This pattern is the epitome of non-detachability. The base-pair sequence pattern is like a blueprint for the flagellum. But the pattern itself would never be recognised unless it were first provided the appropriate environmental context and allowed to express itself in the formation of a flagellar appendage to a bacterial cell. The base-pair sequence pattern in question is not detachable, and the flagellum is not specified in the particular sense required by Dembski's complexity-specification criterion.

The Failed Case for ID

The goal of the Intelligent Design movement is the defeat of naturalism, where the most scientifically relevant tenet of a naturalistic worldview is taken to be its denial of both the need and empirical detectability of supernatural action. ID's primary strategy for achieving this goal is to demonstrate the inability of natural processes to actualise certain biotic structures and to posit that the

46 *NFL*, p. 148.
47 *NFL*, p. 289.

only viable alternative is the assembling of these structures by means of occasional episodes of form-conferring intervention by some non-natural agent. The bacterial flagellum is presented by advocates of ID as a prime example of a biotic structure that exhibits the property of *specified complexity*, which, they argue, cannot be generated by natural processes unless they are supplemented by the form-conferring action of a non-natural agent.

The analysis presented above demonstrates, however, that ID's case for both the *complexity* and *specification* of the bacterial flagellum (as these terms are defined by ID's chief theorist) fail. The flagellum's *complexity*, for example, cannot be demonstrated without an exhaustive knowledge of all relevant natural processes, and the flagellum's *specification* cannot be established merely by appealing to the fact that it has a biological function. The Intelligent Design movement has, in my judgment, failed to demonstrate either the inability of natural processes or the need for non-natural form-conferring action to actualise the bacterial flagellum.

This does not by any means eliminate the desirability of discussing the place of Mind in a worldview that seeks to comprehend the source or character of the universe's being. But claims by the ID movement that some non-natural Intelligence must have intervened in the past to inject specific biotic forms into a universe otherwise incapable of actualising them have failed the test of careful scrutiny.

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