E. COLI AT THE *NO FREE LUNCHROOM*
Bacterial Flagella and Dembski's Case for Intelligent Design

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Draft 7/22/02, for AAAS posting

ABSTRACT: The 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 actualized by the form-conferring action of an unembodied intelligent agent. However, a critical examination of Dembski's case reveals that, 1) it is built on unorthodox and inconsistently applied definitions of both "complex" and "specified," 2) it employs a concept of the flagellum's assembly that is radically out of touch with contemporary genetics and developmental biology, and 3) it fails to demonstrate that the flagellum is either "complex" or "specified" in the manner required to make his case. If the bacterial flagellum is supposed to demonstrate ID, then ID is a failure.*

The Core of Dembski's Case for ID

In his latest book, *No Free Lunch*, William A. Dembski argues at length (as he has done in several other works) that there are natural objects in the world that a) we can unambiguously identify as objects that could not be the outcome of *unguided natural processes* alone, and b) must therefore be the products of *intelligent design*.[1]

How would we recognize these remarkable objects? They exhibit, says Dembski, the empirically detectable quality he calls *specified complexity*. And why is it that these objects must be the products of intelligent design? Because, according to Dembski, unguided natural processes are inherently incapable of generating specified complexity. That is something that only intelligence is able to do.

In the cultural context of the creation-evolution debate, the natural objects of greatest interest here are biological systems. Dembski's favored example is the bacterial flagellum, a quite remarkable molecular machine that functions as a propeller for some bacteria, such as E. coli. This rotary propulsion system also played a prominent role in Michael Behe's book, *Darwin's Black Box*, as an example of a biotic system that exhibits the quality he called *irreducible complexity*. Dembski considers *irreducible* complexity—after he carefully redefines and qualifies the meaning of Behe's term—to be a special form of his more broadly defined *specified* complexity.

Now, if there are biological systems that—because they exhibit specified complexity—could *not* have been actualized 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 intelligent design movement either stands or falls. Hence the subtitle of his book: *Why Specified Complexity Cannot Be Purchased Without Intelligence.*

Why focus on 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 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. Substantial progress has been made in the scientific effort to become acquainted with the numerous processes relevant to evolutionary transformations, but even more remains to be discovered and comprehended.

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."[2] 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."[3] This is the specific claim that we wish to examine.[4]

Getting Acquainted With the ID Vocabulary

Before we proceed with our analysis of Dembski's case for the intelligent design of the bacterial flagellum, we need to invest a substantial effort to become familiar with the fundamental goals and vocabulary of the ID movement. Knowing the broad goals of the movement will help us to understand some elements of its rhetorical strategy. Knowing the vocabulary of the movement is essential because of the strategic manner in which familiar words are often assigned specialized or unusual meanings in ID literature.

The many faces 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 K-12 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* (or *ontological* 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.[5] 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).
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> (2) I use the term *minimal naturalism* (it could also be called *metaphysical* naturalism, but that name has additional connotations) 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. (Intelligent Design advocate

Phillip Johnson frequently uses the term *scientific* naturalism, which appears to be minimal naturalism, as here defined, substantially modified by adding the assertions that natural actions are purposeless and that science provides the *only* reliable pathway to knowledge. Given these additions, Johnson's label, *scientific* naturalism, comes very close to what we are calling *maximal* naturalism.)

(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 doesn't 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 agree on the key proposition to which the ID movement takes exception—that there is no way to detect divine action empirically. The distinctions noted above are judged by ID spokespersons to be hollow *rhetorical* distinctions without an *empirically* discernable difference.

Among the chief claims of the ID movement is that 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."[6] 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 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."[7] The God envisioned by the chief proponents of ID, on the other hand, is a God who makes an empirically detectable difference.

Doing what comes naturally

The ID movement has labored vigorously to formulate a way to determine how things came to be *actualized* (assembled, arranged, organized, 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."[8] When looking at

some *natural object* (any object not crafted by human or animal action, usually some organism or part of an organism), the question for ID advocates is, Could this object have been actualized by means of *natural processes* (or *natural causes*) alone?

Purely natural processes are those that can be fully accounted for by the actions and interactions of the materials (or "stuff") 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 mechanisms* by which atoms, molecules, cells and organisms act, interact, organize 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 (or "guides" them) to bring about an outcome distinctly different from what would otherwise have happened naturally.

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 by 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.*" The comprehensiveness and inclusiveness of these terms must be understood in order to see the extremity of Dembski's numerous claims in *No Free Lunch.*

Darwinism = evolution + 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 (often called microevolution) is often tolerated, as it is even among many young-earth creationists, but the idea of uninterrupted genealogical continuity (or 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.[9]

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 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.[10]

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."[11]

> 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.[12]

What all advocates of ID do seem to be agreed 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 convey. 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 characterize biological evolution as a way of accounting for the formational history of life that is both "thoroughly naturalistic" and "nonteleological." But which form of naturalism does "thoroughly naturalistic" entail? If only *minimal* or *methodological* naturalism, then a number of theistic worldviews could accommodate it. But if the term Darwinism is presumed to entail *maximal* naturalism (or *scientific* naturalism, as Johnson uses the term), then Darwinism effectively becomes a member of the family of atheistic worldviews. This is, I believe, 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.

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 characterization 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."[13]

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's expresses it, "The Darwinian mechanism consists of random variation, which provides the raw material for Darwinian evolution, and natural selection, which sifts that material."[14] Stating this a bit more positively, I would prefer to say that variation functions as a means for searching a portion of the "possibility space" of viable offspring in the genetic vicinity of the parent organisms, and natural selection (the differential survival of varied offspring lines) functions to move populations of organisms toward "fitness peaks" of maximal reproductive success.

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 minute 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?"[15] And in Behe's book, *Darwin's Black Box*, the index listing for "Darwinian evolution" includes the parenthetical 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."[16] And what about various transformational processes or events that fall outside of a strict gradualism? It seems that they are 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."[17] But the real question, it seems to me, is this: Whether these and other such events are considered to fall within the bounds of a strict gradualist definition of the "Darwinian mechanism" or not, *are they relevant to the formational history of life on earth*? The development of novel biotic structures is no respecter of the labels that we might choose to pin on the various factors contributing to their actualization.

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."[18] "Lack of causal specificity leaves one without the means to judge whether a transformation can or cannot be effected."[19]

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, then, should biology 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."[20]

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, a serious problem is introduced into Dembski's analysis when full causal specificity is taken 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 actualization 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.[21] If these scientific hypotheses do not exhibit sufficient causal specificity to allow the computation of a numerical probability for success, then they are likely to be dismissed from ID's consideration. 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.

Three effects of this full causal specificity requirement are easy to identify: (1) There are now numerous biotic structures for which science is unable to formulate causally specific (detailed and complete) accounts of their actualization; (2) In the absence of the causal specificity that it demands of scientific explanations (but not of intelligent design explanations) the ID movement has opportunity to posit its non-natural, intelligent design explanations as alternatives; and (3) Each time a new causally specific scientific explanation for one of these biotic structures is developed, the ID explanation for its actualization becomes superfluous.[22]

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 actualized

(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 actualized by natural processes alone? (2) What does it mean to say that 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.

What do ID advocates actually mean when they say "X was intelligently designed"? 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 major automobile manufacturer and ask to observe the process of cars being designed. What kind of activity would we be shown? 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 center" where we would see people working with their minds (augmented, of course, by computers and various means of modeling what their minds conceive) to conceptualize new cars of various styles to achieve the intentions of the manufacturer in the marketplace. In other words, to say that a car was designed is to say that a car was thoughtfully conceptualized to accomplish some well-defined purpose. In contemporary parlance, *the action of design is performed by a mind, intentionally conceptualizing something for the accomplishment of a purpose.*

This *mind-like* action of *designing* is clearly distinguishable from the *hand-like* action of *actualizing* (assembling, arranging, constructing) what had first been designed. On a tour of an automobile manufacturing facility, for instance, we would have no difficulty in distinguishing the mental work done at the design center 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. William Paley, an eighteenth century English clergyman, spoke eloquently of things like the eye as having been designed, much like 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 conceptualize 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 *actualized* by hand-action. As an artisan, the watchmaker must not only conceptualize 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 *conceptualized* (by mind-like action) *and* skillfully *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 *conceptualizing* some artifact 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 actualize these structures, it is clear that the primary meaning of "X was intelligently designed" is that "X was actualized 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 conceptualization and the hand-like action of constructing or assembling some functional structure, *with a very strong emphasis on "design" as the means of actualization.* Adding the adjective "intelligent" sometimes functions (1) to call attention to the idea that design is an action of an intelligent (choice making) agent, with no claim made regarding the "optimality of design," and sometimes (2) to ensure "that the design we are talking about is not merely apparent but also actual."[23]

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 *actualize* what was first conceptualized.

When considering *embodied* intelligent agents, such as humans or animals, we have no difficulty envisioning how the dual action of conceptualizing and actualizing 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 conceptualize something and actualize 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 conceptualizing 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 actualize 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*."[24] 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."[25] It seems, however, that this particular "separate problem" has been permanently placed in the "solution impossible" file. Dembski's disclaimer that modeling intelligent design action is both unnecessary and at the same time a "separate problem" seems a bit thin.

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 to avoid the problem. "Miracles typically connote a violation or suspension or overriding of natural laws."[26] That is, where a natural cause was set to make X happen, Y happened instead.

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.*[27]

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 actualizing 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 actualization 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 actualize 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? Natural laws were set to bring about the outcome, no flagellum. Instead, a flagellum appeared as the outcome of the Intelligent Designer's action. Is that not a miracle, even by Dembski's own definition? 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 the arrangement of physical stuff seems to require that the designer intervene in, meddle with, or in some way coerce this physical stuff."[28] … "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."[29] 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)."[30] 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? Yes, but that 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."[31] Perhaps, but how might we come to *know* that something has been intelligently designed?

The signs of design

How would we come to know that something was intelligently design? 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.[32]
>
> Whenever we infer design we must establish three things: *contingency, complexity,* and *specification.*[33]

An object/event is said to be *contingent* if, while it is fully consistent with 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 actualized naturally. Dembski looks for objects whose probability of actualization 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 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), *sufficiently complex* (its probability of natural actualization 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 actualized 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. Its single, rod-shaped, prokaryotic cell is surrounded by a rigid but porous cell wall. Immediately inside the cell wall is the plasma membrane, which effectively functions as the barrier between the interior of the cell and its external environment. The nucleoid within the cell contains the cell's circular DNA molecule, which houses E. coli's genetic information.

The genome of E. coli—the instructional information residing in the genetically relevant portion of its DNA—consists of about 4.7 million base pairs, representing approximately 4000 genes. These genes specify the particular character of the numerous RNA and protein molecules that carry out the multitude of diverse tasks that enable the cell to act and interact as it does. 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. The energy for the flagellum's rotary motion is derived from a proton gradient across the bacterial membrane.

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 specific example of what he considers to be an *intelligently designed* biotic structure.

> The flagellum is an acid-powered rotary motor with a whip-like tail whose rotating motion enables a bacterium to navigate through its watery environment. Behe shows that the intricate machinery of this molecular motor—including a rotor, a stator, O-rings, bushings, and a drive shaft—requires the coordinated interactions of about thirty proteins and another twenty or so proteins to assist in their assembly.[34]

> 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.[35]
>
> With regard to a particular biochemical system like the bacterial flagellum, intelligent design asserts that "No undirected natural process could produce this system"[36]

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 actualized only with the assistance of form-conferring interventions by an unembodied intelligent agent.

As I see it, each of these three statements could be challenged, but it should be clear that if the first of these fails, then Dembski's whole system of design inferences built on the premise that *specified complexity is demonstrably present but naturally impossible* also fails. Therefore, 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

Recall that, 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 actualization (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* $P(X) < \alpha$.[37] Note that this makes the "complexity" of X a property, not of X itself, but of the means by which it came to be actualized. This unorthodox employment of the word *complexity* is an essential element in Dembski's case for intelligent design.

Dembski's criterion for complexity is quite easy to state, but that does not mean that it is equally easy 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 actualized, 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."[38] "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?"[39] In the context of applying the complexity-specification criterion, the relevant probability is the probability that X came to be actualized 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 actualized by the joint action of all relevant natural processes, N. (Remember that this "N" is what Dembski most often, *but not always*, means by the term, "chance hypothesis.") The complexity requirement can now be stated more clearly as: *X is complex if* $P(X|N) < \alpha$.

Second, 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) … constitutes 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)."[40] For the moment I need not agree at all with the way in which Dembski argues his case that "natural causes are incapable of generating complex specified information." (In fact, I will later argue that natural causes can have the effect of making the generation of specified complexity wholly unnecessary.) 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. In Dembski's system, testing for the presence of specified complexity must be done in the context of assessing the potential contributions of all relevant natural causes to the actualization of the object in question.

By either route, we come to the same conclusion: To determine if X is *complex* (using Dembski's meaning of the term rather than common usage) we need to compute the value of P(X|N), the probability that X could be actualized 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 $P(X|N) < \alpha$, then Dembski counts X as exhibiting sufficient complexity to proceed with the question regarding its specification.

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 actualized. 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 we know enough to make the calculated value of $P(X|n) > \alpha$, 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? What if, for instance, we were able to propose one or more plausibility arguments regarding the kinds of natural processes that are likely to contribute to P(X|N), but were not yet able to translate these arguments into numerical values for probability?

Dembski does seem to recognize this as a problem when he remarks, "Now it can happen that we may not know enough to determine all the relevant chance hypotheses [which here, as noted above, means *all relevant natural processes* (hvt)]. Alternatively, we might think we know the relevant chance hypotheses, but later discover that we missed a crucial one. In the one case a design inference could not even get going; in the other, it would be mistaken."[41] In principle, this epistemic problem should introduce a considerable degree of modesty in all assessments of probability values related to the question of the complexity of any particular biotic system. Complexity—in the unorthodox sense that Dembski wishes to use this term in his complexity-specification criterion—is an elusive quality. Our ability to determine the presence or absence of it is severely hampered by our limited state of knowledge regarding the specific way in which natural causes have contributed to the formation of biotic structures.

However, the more we learn about the self-organizational 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. For example, in reference to the power of evolutionary algorithms—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*."[42] 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) actualized by natural causes. The question is, however, 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.

The subtitle of *No Free Lunch* is *Why Specified Complexity Cannot Be Purchased Without Intelligence.* Why not? Because "cannot be purchased without intelligence" is effectively included in the definition of specified complexity! Demonstrating that some object actually exhibits specified complexity depends upon the prior demonstration that natural causes are

effectively unable (because of improbability barriers) to actualize that object. The trivial truth of ID's fundamental proposition lies in carefully crafted definitions.

In the absence of a full knowledge of the universe's formational capabilities, computed values for P(X|n) might give the *appearance of complexity* where there is no *actual complexity*. In the light of later discoveries of previously unknown natural formational or transformational processes, this *apparent complexity* would simply vanish like ground fog vaporized in the warmth of sunlight.

And if no biotic systems have this quality of complexity, and thus no specified complexity, then Dembski's prohibitions regarding their natural formation are inconsequential. All of the biotic systems relevant to biotic evolution are free to form as naturally as biologists have long proposed. No free lunch available? No problem; no lunch needed.

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."[43] 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."[44] 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 actualized by the joint action of all relevant natural processes.

Curiously, Dembski not only rejects any proposal consistent with the gradualism 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 *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 *localization probability* = the chance probability of localizing 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 localized.

Dembski repeatedly refers to these probability factors as probabilities that some process (origination, localization, 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," how can we tell which meaning is here intended? In context, and given Dembski's repeated references to these same phenomena as being wholly "random" in character, it would appear that the "pure chance" meaning is the primary meaning here intended. Dembski's method of computation affirms that interpretation.

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 localization 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. By Dembski's measure, it is demonstrable beyond any shadow of doubt that bacterial flagella cannot self-assemble as discrete combinatorial objects.

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* natural 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 discrete combinatorial object that self-assembled in the manner described by Dembski.* Dembski has not defeated any actual biological proposition. He has slain nothing more than an imaginary dragon—a fictitious adversary that Dembski himself has fabricated from a tall stack of rhetorical straw.

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 instruction manual that enables the cell to perform a vast number of functional and formational operations—the coded instructions for growing the flagellar propulsion system. That being the

case, the question relevant to the issue of intelligent design is 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 the extremely awkward position of already having said, in effect, Sure, why not? Recall that Dembski does not consider the bacterium without a flagellum to be designed. He spoke explicitly of "a biological system that does not exhibit an instance of specified complexity (say a bacterium without a flagellum)…."[45] In the context of Dembski's total approach to the formation of biotic systems, that is an astounding admission. As we noted earlier, the genome of E. coli consists of about four million base pairs and encodes approximately four thousand proteins and other biologically relevant molecules. That portion of the genome that codes for the construction of the flagellum comprises only a small fraction of the whole. So, them, how did that flagellum-coding portion come to be actualized without the aid of form-conferring (or information-infusing) intervention by an unembodied intelligent designer? *In the same manner as the majority of the genome*, I would say.

As a matter of fact, the E. coli genome contains genes for the formation of structures remarkably similar to portions of the flagellum system. Bacteria like E. coli possess systems for the secretion of select proteins from the cytoplasm in the cell interior to the extracellular space beyond, often directly into host cells. Several structures are known to accomplish this secretion function. Of special relevance here is the type III secretion apparatus, composed of about 20 proteins, most of which are homologous to the to components of the flagellar biosynthesis apparatus.[46] To put it as simply as possible, the type III secretion apparatus and the "motor apparatus" of the bacterial flagellum employ similar building blocks and share numerous structural features. Thus, the genetic coding for one of these structures is going to be closely related to the genetic coding for the other.

How does Dembski deal with these similarities and relationships? In essence, he ignores them and proceeds to deal with the flagellum in complete isolation from closely related structures in the same E. coli cell. Without explanation, and without even acknowledging the existence of the secretion apparatus or its relationship to the flagellum, Dembski simply asserts that since the flagellar apparatus could not self-assemble by pure chance, it must have required the supplemental action of an "intelligent designer." Meanwhile, the fully natural actualization of the closely related secretion apparatus—part of the bacterium-sans-flagellum—is effectively granted without comment.

If, as Dembski implicitly accepts, forming the majority of the E. coli genome—including the portion dedicated to the actualization of the type III secretion apparatus—did not need the form-conferring intervention of a designer, then why would intervention be necessary for the small additional portion that codes for a flagellum? Suppose, for the sake of argument, that the portion of the E. coli genome that codes for the development of the flagellum comprises 2% of the whole. If, as Dembski claims to have demonstrated, the flagellum is intelligently designed (even though the rest of the bacterium is not) then are we to conclude that the other 98%—which includes the instructions for making the secretion apparatus— could have come to be actualized

without the aid of a designer? Does it not seem odd that the flagellar 2% needed supplementary designer-action while the other 98% did not?

Well, then, suppose that the flagellum really was assembled for the first time by the form-conferring action of an unembodied intelligent designer independently of genomic instructions, as Dembski's approach implies. Since instructions for the development of flagella are now part of the E. coli genome, are we to believe that the designer added those instructions to the genome as a separate act? Are there two independent form-conferring acts here—one for the first flagellum and another for the genomic instructions to produce all subsequent flagella?

I suppose Dembski could argue that a single designer-action would be sufficient—infusing the E. coli genome with the information needed to effect the construction of the flagellum. But then the entirety of Dembski's argument and computation based on treating the flagellum as a discrete combinatorial object would become irrelevant to the question of complexity. Dembski would have to deal openly with the genome and the relationship of its coding for the flagellum with its coding for structurally similar systems like the type III secretion apparatus. In fact, he would have to scrap his original calculation regarding the flagellum as a dco and develop a whole new genetic approach to computing the probability that the flagellum was formed naturally.

Are the flagella of the E. coli bacteria complex? Dembski thinks so, but his strategy of treating the flagellum as a discrete combinatorial object is far off the mark of demonstrating this. The probability value that he claims to have computed has no biological relevance to the question of how flagella of E. coli bacteria were first actualized. Furthermore, if the entire genome for bacteria without flagella (but with closely related secretion devices) can arise naturally without intelligent intervention, the adding of code for the development of flagella seems a rather small detail.

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 at Dembski's development of this portion of his argument for the specified complexity of the flagellum

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. The index of the book cites more than 40 pages dealing with the topics of "specification" and "detachability," plus approximately 100 page-citations for closely related topics such as "specifiability," "specificational resources," "biological specificity," and "specified complexity."

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 that, "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."[47] 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 that, "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."[48] 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.

This use of a human contrivance like the outboard motor as the independent, detachable pattern that certifies the flagellum as being specified bears further scrutiny. Following the quotation above, Dembski continues: "This is not to say that for the biological function of a system to constitute a specification humans must have independently invented a system that performs the same function. Nevertheless, independent invention makes the detachability of a pattern from an event or object all the more stark. At any rate, no biologist I know questions whether the functional systems that arise in biology are specified."[49]

"Specified" in the same technical sense defined by Dembski? Specified by exhibiting an object/event-independent pattern? Not necessarily. We need to look closely at the way in which Dembski first introduced the concepts of specification and detachability. "For a pattern to count as a specification, the important thing is … whether in a certain well-defined sense it is *independent* of the event it describes. Drawing a target around an arrow already embedded in a wall is not independent of the arrow's trajectory."[50] Patterns that satisfy this condition of independence are designated as *detachable*. To determine if some particular pattern is detachable, the following question must be answered affirmatively, says Dembski: "Given an event whose design is in question and a pattern describing it, would we be able to explicitly identify or exhibit that pattern if we had no knowledge of which event occurred?"[51]

To illustrate this test, Dembski uses the "event" of coin-flipping and looks at numerical patterns that might be generated by the sequence of heads and tails transcribed into strings of 0's and 1's. If a string corresponding to the first 100 digits written in binary form appeared, we would be warranted in believing that the sequence did indeed conform to a detachable pattern. That numerical *pattern* could easily be identified independently of the *event* of coin flipping that generated it.

However, to move from Dembski's pattern illustrations involving sequences of numbers or alphabetical letters (as in a sentence of words) to biological systems requires, I believe, far more than a hand-waving reference to biological functions playing the role of detachable pattern. On what basis can Dembski assert, for instance, that "Biological specification always refers to

function"? Is this any different from "drawing a target (representing some particular biological function) around an arrow already embedded in a wall (representing a functioning organism)"? What is the specific function of the flagellum that warrants being counted as a detachable specification pattern? Its function as a means of locomotion? Apparently not. If that were the case, would we not find ID books filled with claims that all animals equipped with any means of locomotion were intelligently designed?

So, then, do only *rotary* motor systems count as biological propulsion systems exhibiting a detachable pattern in their function? On what basis would other propulsion systems be disqualified? How narrowly does Dembski define biological function? And where does he develop a system for determining that some functions count toward specification and others do not? If it really is the case that, as Dembski states, "Biological specification always refers to function," wouldn't *all* biological functions then count as detachable patterns exhibited by biological systems?

Apparently not. Recall that, by Dembski's measure, a bacterium without a flagellum does *not* exhibit an instance of specified complexity. For reasons that are not explained, of all the remarkable biological functions in which the bacterium-sans-flagellum participates, none appears to satisfy Dembski's criterion of specification. On what basis is the function of the flagellum singled out as the only bacterial function that is sufficiently spectacular as to require the assistance of an unembodied intelligent designer to actualize?

However, perhaps there is another approach that deserves investigation. In our reflections on the question, Is the flagellum complex? we argued that the focus of attention should be shifted from the flagellum structure itself to the portion of the E. coli genome that coded for its development. If that is correct, as it must be, 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 characterizes the genetic coding for the flagellum, right? Right, but the crucial question is, Is that pattern *detachable* from the event under consideration, *E. coli develops a flagellum*?

I believe the answer must be a resounding, No. The pattern in the base-pair sequence associated with this flagellum-actualization event is unique to that event and to that event alone. This pattern is the epitome of non-detachability. The pattern and the event are not independent, but stand in a one-to-one relationship. The base pair sequence pattern is like a blueprint for the flagellum. The pattern in question is not detachable, and the flagellum is not specified in the particular sense required by Dembski's complexity-specification criterion.

Bacterial Flagella and Dembski's Case for Intelligent Design: Closing Arguments

Earlier in this critique we outlined Dembski's case for the proposition—*bacterial flagella are intelligently designed*—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 actualized only with the assistance of form-conferring interventions by an unembodied intelligent agent.

We then focused our attention on the first of these statements and asked, Does the bacterial flagellum exhibit "specified complexity" as it is defined by Dembski? In order to do that it would have to be a) sufficiently complex, and b) specified.

Is the bacterial flagellum sufficiently complex? Using Dembski's own criterion, only if the probability of its being actualized by the joint action of all natural causes is less than the universal probability bound. Dembski attempted to demonstrate this to be true by treating the bacterial flagellum as if it were a discrete combinatorial object actualized by the pure chance gathering of 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. The only natural formational process that Dembski considered in his probability computation was self-assembly by pure happenstance.

We reject that argument as being a totally unrealistic caricature of how the flagellum is actualized and an approach that totally ignores the role of the bacterial genome in coding for all of the structures and functions that contribute to the nature of E. coli. Furthermore, if, as Dembski himself states, a bacterium without a flagellum does not exhibit specified complexity, then the addition of a flagellum could be accomplished in whatever non-designed way (that is, without need for non-natural intervention) that the rest of the bacterium (which includes structures remarkably similar to parts of the flagellum) came to be actualized. If the actualization by natural causes of an entire cell (without a flagellum) is not sufficiently difficult to qualify the cell as complex by Dembski's standards, then neither is the addition of a flagellum. Dembski's case for the *complexity* (as he defines it) of the bacterial flagellum fails.

Is the bacterial flagellum specified? Using Dembski's own criterion, only if it exhibits a pattern that is detachable—wholly independent of the event that produced it. Appearing to set aside his laboriously crafted formalism regarding the specification and detachability requirements, Dembski simply asserts that in the case of *biological* systems specification always refers to function, and declares that biological functions are inherently detachable from the particular biological systems that instantiate them.

We reject that argument for a number of reasons. First, the general principle that biological function counts for specification was never established by Dembski. Second, his application of this principle appears to be entirely ad hoc. Dembski provides no systematic means for concluding that the function of the flagellum should count as a detachable specification while other equally remarkable biological functions of E. coli fail to qualify. For instance, if none of the functions of a bacterium-sans-flagellum qualify the bacterium as being specified, then there appears to be no basis for counting the function of the flagellum any differently. If none of the

other biological functions of the bacterium count as a detachable specification, then neither should the function of the flagellum. Dembski's case for the *specification* (as he defines it) of the flagellum fails.

Finally, there is the broad question concerning Dembski's rhetorical use of key terms like *complexity* and *specification*. On the question of specification, for instance, Dembski asserts that, "no biologist I know questions whether the functional systems that arise in biology are specified."[52] The question is, however, Is Dembski using the term "specified" in the same way as the biologists he has in mind? The answer, I believe, is, No. Dembski treats the presence of biological function as if it constituted a detachable pattern independent of the organism under scrutiny. For Dembski, biological function is one of the qualities of a complex organism that only intelligent intervention could produce. For biology, on the other hand, biological function plays nearly the opposite role. It is the very capacity of an organism that gives it the ability to respond to its environment in the manner described by a fitness function, a phenomenon that lies at the heart of evolutionary dynamics.

A similar concern about Dembski's use of key terms arises in regard to the meaning of "complexity." After quoting a number of prominent biologists regarding the scientific challenge of accounting for the information now resident in complex biological systems, Dembski asks, "But what sort of information are they talking about?"[53] He soon answers his question in a way that appears to place their concern squarely in his own design-theoretic court. "I submit that what they have in mind is specified complexity, or what equivalently we have been calling … complex specified information. Certainly the complexity of biological information is not at issue."[54] But of course this bold assertion could be true only if Dembski is using the term "complexity" in the same way as the persons he quoted, which seems not to be the case. As we saw in our general considerations on complexity, the "complexity" that Dembski computes is a property, not of some biotic system itself, but of the means by which it becomes actualized. That is why, for instance, he treated the bacterial flagellum as if it were a discrete combinatorial object and judged its complexity on the basis of the probability of its coming to be actualized by pure chance alone. Most biologists, on the other hand, use the term "complexity" as the name of something quite different—a structural or functional quality of the biotic system itself.

But "specification" and "complexity" are not the only terms that Dembski, like other leaders of the ID movement, employs rhetorically with unorthodox meanings. Recall, for instance, that to be "intelligently designed" is, in effect, to be *assembled with the aid of form-conferring (or information-infusing) action performed by an unnamed and unembodied choice-making agent.* Recall also that when this *unembodied intelligent agent brings about a naturally impossible outcome*, it is not a "miracle." And recall that "chance hypothesis" most often means *all hypotheses, postulates and theories concerning the natural causation of events*. The case for ID relies on a web of words that have been assigned extraordinarily unusual meanings.

Given this character trait of ID literature, including such works as Dembski's *No Free Lunch*, would it not be appropriate to suggest that Dembski pause to reflect on his own admonition regarding the need to use words appropriately, consistently, and with precision to avoid the charge of equivocation? Says Dembski, "The fallacy of equivocation is the fallacy of speaking out of both sides of your mouth. It is the deliberate confusing of two senses of a term, using the

sense that's convenient to one's agenda."[55] I agree. Ironically, however, I find Dembski's rhetoric to be riddled with the very equivocation that he condemns.

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[1] 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.
[2] *NFL*, p. 355.
[3] *NFL*, pp. 331-332.
[4] This essay focuses on the ID movement's principal scientific claim and the rhetorical strategies employed to support it. I also have 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.
[5] 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.
[6] *NFL*, p. 367.
[7] Phillip E. Johnson, *Darwin on Trial* (Downers Grove, IL: InterVarsity Press, 1991), p. 115.
[8] *NFL*, p. 372n4.
[9] *Darwin on Trial*, p. 150.
[10] Michael J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: The Free Press, 1996), p. 5.
[11] *NFL*, p. 314.
[12] NFL, pp. 314-315.
[13] In anti-evolutionist literature it is often implied that the presence of randomness in natural processes such as *random* variation or natural (*unguided*) selection completely displaces the idea of goals, purposes or intentions. But that is simply not the case. Although the idea that each individual event in evolutionary history is purposefully intended or in conformity to some predetermined plan may have to be set aside, that does not at all eliminate the possibility that the evolutionary process as a whole might well be serving some comprehensive purpose. As an illustration, suppose there were a completely honest gambling casino in which pure randomness characterized every roll of the dice, every spin of the wheel, every turn of the card, etc. Nonetheless, the casino accomplishes its purpose of bringing a handsome profit to the bank at the end of each day. In fact, the owners of the casino depend on authentic randomness in their computation of payout rates in order to accomplish their goal of making a profit. Randomness at one level does not exclude purpose at another. Randomness can be purposefully employed.
[14] *NFL*, p. 286.
[15] *Darwin's Black Box*, p. 34.
[16] *NFL*, p. 286.
[17] *NFL*, p. 287.
[18] *NFL*, p. 240.
[19] *NFL*, p. 242.
[20] *NFL*, p. 244
[21] 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.
[22] 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…."
[23] See *NFL*, pp. xvi-xvii.
[24] *NFL*, p. 330.

[25] *NFL*, p. 112.
[26] *NFL*, p. 326.
[27] *NFL*, p. 326.
[28] *NFL*, p. 334.
[29] *NFL*, p. 335.
[30] *NFL*, p. 343
[31] *NFL*, p. 343
[32] *NFL*, p. 6.
[33] *NFL*, p. 8.
[34] *NFL*, pp. 249-250.
[35] *NFL*, p. 250.
[36] *NFL*, p. 272.
[37] See *NFL*, pp. 18-22, for a discussion on the universal probability bound and Dembski's employment of it.
[38] *NFL*, p. 19.
[39] *NFL*, p. 21.
[40] *NFL*, p. 150.
[41] *NFL*, p. 123n80.
[42] *NFL*, pp. 182-183.
[43] *NFL*, p. 288.
[44] *NFL*, p. 289.
[45] *NFL*, p. 331.
[46] See the review article by Christoph J. Heuck, "Type III Protein Secretion Systems in Bacterial Pathogens of Animals and Plants," in *Microbiology and Molecular Biology Reviews*, June 1998, Vol. 62, No. 2, pp. 379-433
[47] *NFL*, p. 148.
[48] *NFL*, p. 289.
[49] *NFL*, p. 289.
[50] *NFL*, p. 15.
[51] *NFL*, p. 15.
[52] *NFL*, p. 289.
[53] *NFL*, p. 148.
[54] *NFL*, p. 148.
[55] William A. Dembski, *Intelligent Design: The Bridge Between Science & Theology* (Downers grove, IL: InterVarsity Press, 1999), p. 115.