

STILL SPINNING JUST FINE: A RESPONSE TO KEN MILLER

By William A. Dembski, 2.17.03, v.1.01

When I read Ken Miller's contribution to the volume I'm editing with Michael Ruse (*Debating Design: From Darwin to DNA*, Cambridge University Press, forthcoming 2004), I expected I'd have till the actual publication date next year to respond to it. But since Miller's contribution has now officially appeared on his website (<http://www.millerandlevine.com/km/evol/design2/article.html> -- it is titled "The Flagellum Unspun: The Collapse of 'Irreducible Complexity'"), I want to comment on it at this time. I'll go through Miller's paper sequentially and respond bullet-point fashion.

The Argument from Personal Incredulity:

Miller claims that the problem with anti-evolutionists like Michael Behe and me is a failure of imagination -- that we personally cannot "imagine how evolutionary mechanisms might have produced a certain species, organ, or structure." He then emphasizes that such claims are "personal," merely pointing up the limitations of those who make them. Let's get real. The problem is not that we in the intelligent design community, whom Miller incorrectly calls "anti-evolutionists," just can't imagine how those systems arose. The problem is that Ken Miller and the entire biological community haven't figured out how those systems arose. It's not a question of personal incredulity but of *global disciplinary failure* (the discipline here being biology) and *gross theoretical inadequacy* (the theory here being Darwin's). Darwin's theory, without which nothing in biology is supposed to make sense, in fact offers no insight into how the flagellum arose. If the biological community had even an inkling of how such systems arose by naturalistic mechanisms, Miller would not -- a full six years after the publication of *Darwin's Black Box* by Michael Behe -- be lamely gesturing at the type three secretory system as a possible evolutionary precursor to the flagellum. It would suffice simply to provide a detailed explanation of how a system like the bacterial flagellum arose by Darwinian means. Miller's paper, despite its intimidating title ("The Flagellum Unspun") does nothing to answer that question.

Getting from Irreducible Complexity to Design:

Miller, in line with his personal incredulity criticism, charges design proponents of reasoning directly from the premise "Shucks, no one has figured out how the flagellum arose" to the conclusion "Gee, it must have been designed." Miller, despite a long exposure to ID thinkers and their writings, continually misses a crucial connecting link in the argument. So let me spell out the premises of the argument as well as its conclusion: Certain biological systems have a feature, call it IC (irreducible complexity). Darwinians don't have a clue how biological systems with that feature originated (Miller disputes this premise, but we'll come back to it). We know that intelligent agency has the causal power to produce systems that exhibit IC (e.g., many human artifacts exhibit IC). Therefore, biological systems that exhibit IC are likely to be designed. Design theorists, in attributing design to systems that exhibit IC, are simply doing what scientists do generally, which is to attempt to formulate a causally adequate explanation of the phenomenon in question.

Irreducible Complexity Is Not Properly Ascribed to the Bacterial Flagellum:

According to Miller, Behe's claim that the bacterial flagellum is irreducibly complex is false. If Miller is right, then Behe and the intelligent design movement are in deep trouble. Think of it: Behe goes to all this bother to formulate some feature of biochemical systems that is a clear marker of intelligent agency and that decisively precludes the Darwinian mechanism. Behe then asserts that the bacterial flagellum exhibits that feature. Rather than argue about whether that feature reliably signals design or effectively precludes Darwinism, Miller claims to show that when it comes to the design community's best example of irreducible complexity -- the bacterial flagellum -- that it isn't even irreducibly complex. *What idiots these design theorists must be if they can't even apply correctly the very concepts they've defined!*

I'll let Behe respond for himself to this line of criticism. Behe's response will appear in the same volume that I'm editing with Michael Ruse (the one featuring Miller's piece discussed here). Miller has been recycling this criticism for some time now (the first time I heard it was at the *Design and Its Critics* conference at Concordia University, Mequon, Wisconsin, June 2000). This time around Behe is responding to Miller's criticism at a debate between the two of them at the American Museum of Natural History (April 23, 2002). Behe (2004) writes:

"If nothing else, one has to admire the breathtaking audacity of verbally trying to turn another severe problem for Darwinism into an advantage. In recent years it has been shown that the bacterial flagellum is an even more sophisticated system than had been thought. Not only does it act as a rotary propulsion device, it also contains within itself an elegant mechanism to transport the proteins that make up the outer portion of the machine, from the inside of the cell to the outside. (Aizawa 1996) Without blinking, Miller asserted that the flagellum is not irreducibly complex because some proteins of the flagellum could be missing and the remainder could still transport proteins, perhaps independently. (Proteins similar -- but not identical -- to some found in the flagellum occur in the type III secretory system of some bacteria. See Hueck 1998). Again he was equivocating, switching the focus from the function of the system to act as a rotary propulsion machine to the ability of a subset of the system to transport proteins across a membrane. However, taking away the parts of the flagellum certainly destroys the ability of the system to act as a rotary propulsion machine, as I have argued. Thus, contra Miller, the flagellum is indeed irreducibly complex. What's more, the function of transporting proteins has as little directly to do with the function of rotary propulsion as a toothpick has to do with a mousetrap. So discovering the supportive function of transporting proteins tells us precisely nothing about how Darwinian processes might have put together a rotary propulsion machine."

To this let me add: A system is irreducibly complex in Behe's sense if all its parts are indispensable to preserving the system's basic function. That an irreducibly complex system may have subsystems that have functions of their own (functions distinct from that of the original system) is therefore allowed in the definition. It seems that Miller is unclear about the distinction between a *definition* and an *argument*. Irreducible

complexity is a well-defined notion that is appropriately and ascertainably applied to the bacterial flagellum. Miller's concern ultimately seems not over the definition but over its use as an argument to rebut Darwinism. Miller's point here generally is that if subsystems can be found with functions of their own (perforce different from that of the original system since otherwise the original system would not be irreducibly complex), then those subsystems and their functions can be grist for selection's mill and underwrite a Darwinian account of how the original system arose. Let's now turn to that possibility.

Connecting the Type III Secretory System to Bacterial Flagellum:

Miller's whole argument that the bacterial flagellum evolved by Darwinian means rests on the existence of the type III secretory system (TTSS). The TTSS is coded for by about ten genes, each of which is homologous to genes in the bacterial flagellum. Thus Miller sees the TTSS as embedded in the bacterial flagellum, capable of being selected for on its own, and as a possible evolutionary precursor to the flagellum. He writes: "The TTSS does not tell us how either it or the flagellum evolved. This is certainly true, although Aizawa has suggested that the TTSS may indeed be an evolutionary precursor of the flagellum (Aizawa 2001)."

Accordingly, the TTSS may be thought of as a possible subsystem of the flagellum that performs a function distinct from the flagellum. Nevertheless, finding a subsystem of a functional system that performs some other function is hardly an argument for the original system evolving from that other system. One might just as well say that because the motor of a motorcycle can be used as a blender, therefore the motor evolved into the motorcycle. Perhaps, but not without intelligent design. Indeed, multipart, tightly integrated functional systems almost invariably contain multipart subsystems that serve some different function. At best the TTSS represents one possible step in the indirect Darwinian evolution of the bacterial flagellum. But that still wouldn't constitute a solution to the evolution of the bacterial flagellum. What's needed is a complete evolutionary path and not merely a possible oasis along the way. To claim otherwise is like saying we can travel by foot from Los Angeles to Tokyo because we've discovered the Hawaiian Islands. Evolutionary biology needs to do better than that.

There's another problem here. The whole point of bringing up the TTSS was to posit it as an evolutionary precursor to the bacterial flagellum. The best current molecular evidence, however, points to the TTSS as evolving from the flagellum and not vice versa (Nguyen et al. 2000). This can also be seen intuitively. The bacterial flagellum is a motility structure for propelling a bacterium through its watery environment. Water has been around since the origin of life. But the TTSS, as Mike Gene (see citation at end) notes, is restricted "to animal and plant pathogens." Accordingly, the TTSS could only have been around since the rise of metazoans. Gene continues: "In fact, the function of the system depends on intimate contact with these multicellular organisms. This all indicates this system arose after plants and animals appeared. In fact, the type III genes of plant pathogens are more similar to their own flagellar genes than the type III genes of animal pathogens. This has led some to propose that the type III system arose in plant pathogens and then spread to animal pathogens by horizontal transfer.... When we look at the type III system its genes are commonly clustered and found on large virulence plasmids.

When they are in the chromosome, their GC content is typically lower than the GC content of the surrounding genome. In other words, there is good reason to invoke horizontal transfer to explain type III distribution. In contrast, flagellar genes are usually split into three or more operons, they are not found on plasmids, and their GC content is the same as the surrounding genome. There is no evidence that the flagellum has been spread about by horizontal transfer."

It follows that the TTSS does not explain the evolution of the flagellum (despite the handwaving of Aizawa 2001). Nor, for that matter, does the bacterial flagellum explain in any meaningful sense the evolution of the TTSS. The TTSS is after all much simpler than the flagellum. The TTSS contains ten or so proteins that are homologous to proteins in the flagellum. The flagellum requires an additional thirty or forty proteins, which are unique. Evolution needs to explain the emergence of complexity from simplicity. But if the TTSS evolved from the flagellum, then all we've done is explain the simpler in terms of the more complex.

The scientific literature shows a complete absence of concrete, causally detailed proposals for how coevolution and co-option might actually produce irreducibly complex biochemical systems. In place of such proposals, Darwinists simply observe that because subsystems of irreducibly complex systems might be functional, any such functions could be selected by natural selection. Accordingly, selection can work on those parts and thereby form irreducibly complex systems. All of this is highly speculative, and accounts for cell biologist Franklin Harold's (2001, 205) frank admission: "There are presently no detailed Darwinian accounts of the evolution of any biochemical or cellular system, only a variety of wishful speculations."

When I challenged Ken Miller with this quote at the World Skeptics Conference organized by CSICOP summer 2002 (for a summary of the conference see <http://www.csicop.org/si/2002-09/conference.html>), Miller did not challenge the substance of Harold's claim. Rather, he merely asserted that Harold had been retired a number of years. The implication I took was that Harold was old and out of touch with current biological thinking and therefore could be ignored (in which case one has to wonder what the editors at Oxford University Press were thinking when they agreed to publish Harold's book). I wish that at the skeptics conference I had followed up more forcefully on Miller's glib dismissal of Harold. Perhaps Miller will see my response here and clarify why Harold's retirement has anything to do with the substance of Harold's claim.

To sum up, the Darwinian mechanism requires a selectable function if that mechanism is going to work at all. Moreover, functional pieces pulled together from various systems via coevolution and co-option are selectable by the Darwinian mechanism. But what is selectable here is the individual functions of the individual pieces and not the function of the yet-to-be-produced system. The Darwinian mechanism selects for preexisting function. It does not select for future function. Once that function is realized, the Darwinian mechanism can select for it as well. But making the transition from existing function to novel function is the hard part. How does one get from functional pieces that

are selectable in terms of their individual functions to a system that consists of those pieces and exhibits a novel function? The Darwinian mechanism is no help here. Darwin himself conceded this point. Writing in the *Origin*, he noted: "Unless profitable variations do occur, natural selection can do nothing." To say that those profitable variations are random errors is to beg precisely the point in question.

Irreducible Complexity Hasn't Shown Darwinism to Be Logically Impossible:

Miller writes: "The doctrine of irreducible complexity was intended to go one step beyond the claim of ignorance. It was fashioned in order to provide a rationale for claiming that the bacterial flagellum couldn't have evolved, even in principle, because it is irreducibly complex. Now that a simpler, functional system (the TTSS) has been discovered among the protein components of the flagellum, the claim of irreducible complexity has collapsed, and with it any 'evidence' that the flagellum was designed."

Miller is convinced that intelligent design must be after logical certainty and mathematical proof in eliminating natural mechanisms for the emergence of certain types of biological complexity and that if ID proponents cannot attain that level of certainty, then our efforts are wasted. What's more, Miller rightly maintains that no logical impossibility prevents the Darwinian mechanism from bringing about Behe's irreducibly complex biochemical systems -- taken as a mere conceptual possibility, the TTSS might be a precursor to the bacterial flagellum via a Darwinian evolutionary pathway (absent any details, just about anything is after all logically or conceptually possible). Thus, if strict logical certainty were our aim, our case against Darwinian evolution would indeed "collapse," much as any putative theorem in mathematics would "collapse" if the justification offered did not follow as a strict logical deduction from accepted axioms or premises.

But logical certainty or mathematical proof were never the issue. We are, after all, in the realm of science and empirics and not in the realm of pure mathematics and logic when it comes to understanding the emergence of biological complexity (despite mathematics' relevance to the discussion). In consequence, logical possibility and impossibility had better not be our only criteria for assessing the emergence of biological complexity. If they were, we wouldn't need Darwin. Indeed, there's no logical impossibility for some vastly improbable thermodynamic accident to bring about all the nifty life forms we see in nature. Chance unaided by natural selection is fully capable of accounting for biology if logical possibility and impossibility are our only constraints on theory construction.

Yet for Miller, intelligent design purports to show that it is logically impossible for the Darwinian mechanism to generate irreducibly complex biochemical systems. And since there is in fact no logical impossibility for the Darwinian mechanism to accomplish this feat, intelligent design has no traction against Darwinism and can safely be ignored (at least on scientific, though perhaps not on political, grounds). The question we should therefore be asking is why Miller, as a scientist, raises the standard so high against intelligent design. Certainly he realizes that as a criterion for judging claims, strict logical possibility/impossibility applies only in mathematics. Miller might answer that intelligent design proponents have themselves set so high a standard and that he is merely reporting

that fact. But Miller is responding to Behe and me. For my part, I carefully avoid tying intelligent design's critique of Darwinism to the unreasonably high standard of logical impossibility or mathematical certainty (though, granted, I employ mathematics). Nor does a charitable reading of Behe yield such an interpretation. So let me pose the question again: Why is intelligent design held to such a high standard when that standard is absent from the rest of the empirical sciences (nowhere else in the natural sciences is strict logical possibility/impossibility enforced, not even with the best established physical laws like the first and second laws of thermodynamics)?

What's behind this double-standard is a curious logic that propels evolutionary reasoning. I call it *evolutionary logic* or the *logic of credulity*. Evolutionary logic takes the form of a *reductio ad absurdum*. The absurdity is intelligent design or more generally any substantive teleology. For evolutionary biologists, to treat design or teleology as fundamental modes of explanation capable of accounting for the emergence of biological structures is totally unacceptable. Any valid argument that concludes design in such cases must therefore derive from faulty premises. Thus, in particular, any claim that entails, makes probable, or otherwise implicates design in the emergence of biological structures must be rejected. But evolutionary logic doesn't stop there. Not only must any claim that supports design be rejected, but any claim that rules out design thereby demands assent and commands belief. Hence evolution's logic of credulity -- belief in an evolutionary claim is enjoined simply because it acts as a defeater to design and not because any actual evidence supports it.

Miller's appeal to the TTSS as a precursor on an indirect Darwinian pathway to the bacterial flagellum is a case in point. Behe has decisively ruled out direct Darwinian pathways as unable to account for irreducibly complex biochemical systems (a direct Darwinian pathway being one where a system evolves by improving a fixed given function). If indirect Darwinian pathways could also be ruled out as unable to account for such systems, that would sink Darwinism and support intelligent design (an indirect Darwinian pathway being one where a system evolves by also modifying its function). But intelligent design in biology is unthinkable -- *you can't go there!* So anything that leads you there must be rejected and anything that protects you from going there receives support. The Darwinian conclusion: indirect Darwinian pathways are not ruled out and in fact account for the way such systems evolved. This is a counsel of credulity: Believe despite the lack of evidence because the alternative is unthinkable.

Behe decisively closes off avenues by which the Darwinian mechanism could have given rise to irreducibly complex systems. Yet instead of casting doubt on the Darwinian mechanism, Behe's closing off of avenues merely confirms for Miller that the Darwinian mechanism operated through other avenues, which have the advantage of being completely unspecified and unsupported by empirical evidence, to wit, indirect Darwinian pathways. Behe rules out ways the Darwinian hypothesis might be true. Is this hypothesis therefore disconfirmed or brought into question? No. Instead, ways (however implausible) that the Darwinian hypothesis might remain true are thereby confirmed.

Miller's Foray into the Mathematics of the Design Inference:

Miller critiques my combinatorial analysis of the bacterial flagellum from section 5.10 of *No Free Lunch* (2002). He makes two main points: (1) That the combinatorial analysis I develop cannot properly be applied to the flagellum. (2) That any such analysis presupposes the very outcome that ID theorists are supposed to be establishing, namely, that the bacterial flagellum is beyond the remit the Darwinian mechanism (or, as Miller puts it, the ID approach "assumes impossibility").

As for (1), Miller writes: "This approach [i.e., breaking the probability of the flagellum into an origination, localization, and configuration probability] overlooks the fact that the last two probabilities [i.e., localization and configuration] are actually contained within the first. Localization and self-assembly of complex protein structures in prokaryotic cells are properties generally determined by signals built into the primary structures of the proteins themselves. The same is likely true for the amino acid sequences of the 30 or so protein components of the flagellum and the approximately 20 proteins involved in the flagellum's assembly.... Therefore, if one gets the sequences of all the proteins right, localization and assembly will take care of themselves. To the ID enthusiast, however, this is a point of little concern."

Actually, I made a similar point in *No Free Lunch* (2002, 300): "An objection may now be raised against this analysis.... The parts of a flagellum do not have to simultaneously converge [i.e., localize] by chance -- they self-assemble in order when chance collisions allow specific, cooperative, local electrostatic interactions to lock the structure together, one piece at a time." Localization and configuration seem to come along for free once you've got origination. But this is too simple. We can imagine the various proteins that go into a flagellum occurring in, let's say, three distinct molecular machines within a bacterium that lacks a flagellum. Although all the proteins are there for the flagellum, no flagella are formed. Why? Because genetic regulation within the bacterium targets the proteins to the specific molecular machines within which they occur. It's not enough for the proteins merely to be formed and then automatically snap together to form a flagellum. The localization probability therefore refers to such regulation.

Similarly with configuration, we can imagine proteins homologous to those of a flagellum all being in a bacterial cell. Moreover, we can imagine genetic regulation targeting all these proteins to the same location in the right order to build a flagellum. And yet, if these proteins are perturbed from their precise amino-acid sequencing in the flagellum, they will in all likelihood not be adapted to each other and therefore fail to form a functioning flagellum. Thus, even though localization and configuration probabilities can be thought to be built into the origination probability, in fact they are separable and a probabilistic analysis rightly takes into account their separability. Miller's point is indeed of concern to ID enthusiasts, as any charitable reading of our work would make clear.

And that brings us to point (2), in which Miller argues that the probabilistic analysis I offer is irrelevant to calculating the probabilities actually connected with the emergence of the bacterial flagellum. He writes: "By treating the flagellum as a 'discrete

combinatorial object' [Dembski] has shown only that it is unlikely that the parts [of the] flagellum could assemble spontaneously. Unfortunately for his argument, no scientist has ever proposed that the flagellum or any other complex object evolved that way. Dembski, therefore, has constructed a classic 'straw man' and blown it away with an irrelevant calculation. By treating the flagellum as a discrete combinatorial object he has assumed in his calculation that no subset of the 30 or so proteins of the flagellum could have biological activity. As we have already seen, this is wrong. Nearly a third of those proteins are closely related to components of the TTSS, which does indeed have biological activity. A calculation that ignores that fact has no scientific validity."

First off, it's easy to see that the calculation is indeed relevant, for if the spontaneous formation of the proteins occurring in the flagellum had high joint probability, ID theorists and Darwinians would be agreed that the flagellum would not be a system that required design -- if the probability of the parts of the flagellum forming spontaneously were high, the bacterial flagellum's design would be refuted. So Miller's point, presumably, is not that such calculations are irrelevant but that they don't go far enough, namely, that they don't treat the probabilities that might arise from a Darwinian pathway leading to the flagellum.

But in fact they do. My point in section 5.10 was not to calculate every conceivable probability connected with the stochastic formation of the flagellum (note that the Darwinian mechanism is a stochastic process). My point, rather, was to sketch out some probabilistic techniques that could then be applied by biologists to the stochastic formation of the flagellum. As I emphasized in *No Free Lunch* (2002, 302): "There is plenty of biological work here to be done. The big challenge is to firm up these numbers and make sure they do not cheat in anybody's favor."

Miller doesn't like my number $10^{(-1170)}$, which is one improbability that I calculate for the flagellum. Fine. But in pointing out that a third of the proteins in the flagellum are closely related to components of the TTSS, Miller tacitly admits that two-thirds of the proteins in the flagellum are unique. In fact they are (indeed, if they weren't, Miller would be sure to point us to where the homologues could be found). Applied to those remaining two-third of flagellar proteins, my calculation yields something like $10^{(-780)}$, which also falls well below my universal probability bound.

But let's suppose we found several molecular systems like the TTSS that jointly took into account all the flagellar proteins (assume for simplicity no shared or extraneous proteins). Those proteins would be similar but, in all likelihood, not identical to the flagellar proteins (strict identity would itself be vastly improbable). But that then raises the question how those several molecular machines can come together so that proteins from one molecular machine adapt to proteins from another molecular machine to form an integrated functional system like the flagellum. As John Bracht (2003) points out: "The problem is that the proteins which are to become the flagellum are coming from systems that are distinctly non-flagellar in nature (after all, we are discussing the origin of that very system) and being co-modified from their original molecular interactions into an entirely new set of molecular interactions. Old interfaces and binding sites must be

removed and new ones must be created. But given the sheer number of flagellar proteins that must co-evolve, [thereby] co-generating all the proteins required for flagellar function (again, this is true *at some point in the flagellum's evolutionary past even if there were earlier steps that were not so tightly constrained*), the Darwinian explanation is really no different from appealing to a miracle."

We can do the probabilistic analysis at the level of individual proteins as I did in *No Free Lunch*. Or we can do it at higher levels of organization like functional subsystems (e.g., the TTSS). But all such probabilistic analyses still point up vast improbabilities. If Miller is right about Darwinian evolution being responsible for the bacterial flagellum, there had to exist bacterial genomes $A = A_1$ through $A_n = B$ where one genome represents an evolutionary precursor to the next such that $A (= A_1)$ contains no flagellar genes (not even homologues) and $B (= A_n)$ has the operons for a fully functioning flagellum. Moreover, the change from A_i to $A_{(i+1)}$ must in each case be reasonably probable in the light of any selection pressure operating on the organisms containing those genomes. Miller of course has nothing like this -- no such sequence and no such probabilistic analysis (i.e., no probabilistic analysis showing $P(A_{(i+1)}|A_i) \gg 0$). He has B (e.g., the genome of *E. coli*) and C (e.g., the genome of *Yersinia pestis*, which codes for the TTSS), and he has no good argument for why C should fall somewhere within the progression A_1 through A_n , much less whether there even is such a progression.

In *No Free Lunch*, I offer a way to try to get a handle on such progressions through what I call perturbation identity and tolerance factors (see section 5.10). The idea is to take a functional system, perturb it, and determine how perturbation affects the probability of retaining function. If the probability of retaining function is high, then this would constitute evidence that a Darwinian pathway could readily lead to the system in question. Essentially the idea here is one used in AI search strategies. Miller's task, to vindicate Darwinism in regard to the flagellum, is to exhibit a *forward chaining* search through genomic space that issues in a genome coding for the flagellum. But neither he nor anyone else in the biological community can do this. So an alternative approach is to try a *backward chaining* search that preserves function. What I show through my perturbation probabilities is that such searches face huge probabilistic hurdles. What this means is that if a forward chaining search succeeds, it does so as a highly specific and isolated path through genomic space. In that case the step-by-step probabilities moving forward from A_i to $A_{(i+1)}$ could still be large enough not to overturn my universal probability bound. But absent a successful forward chaining search, there is no reason to think that success is even possible. Successful forward chaining assumes that a sequence like A_1 through A_n and can be made explicit. There is no evidence of this.

In fact, if we look to human invention, we have all the more reason to think that the Darwinian mechanism cannot account for successful forward chaining searches and thus for systems like the bacterial flagellum. The field of technological evolution broadly distinguishes between routine and innovative problems (see Savransky 2000 as well as Dembski 2001 and Bracht 2001). Routine problems are amenable to trial-and-error problem-solving techniques (of which the Darwinian mechanism constitutes an instance). Innovative problems, by contrast, require conceptual insights that transcend trial-and-

error tinkering. Moreover, in human experience, irreducibly complex designed systems are invariably solutions to innovative, not routine, problems. Since we don't expect trial and error to produce irreducible complexity in the human context, why should we expect it to produce it in the biological context? The usual counterargument here is to charge anthropomorphism and invoke deep time -- natural selection should not be compared to human activity and natural selection has unimaginably more time to work with than human trial-and-error tinkering. But neither of these criticisms holds water. Humans can mimic undirected selection and they can now do it very fast on the computer, thereby compressing deep time into ordinary time. And nevertheless, it remains the case that no genetic algorithm or evolutionary computation has designed a complex, multipart, functionally integrated, irreducibly complex system without stacking the deck by incorporating the very solution that was supposed to be attained from scratch (Dawkins 1986 and Schneider 2000 are among the worst offenders here).

Bottom line: Calculate the probability of getting a flagellum by stochastic (and that includes Darwinian) means any way you like, *but do calculate it*. All such calculations to date have fallen well below my universal probability bound of 10^{-150} . But for Miller all such calculations are besides the point because a Darwinian pathway, though completely unknown, most assuredly exists and, once made explicit, would produce probabilities above my universal probability bound. To be sure, if a Darwinian pathway exists, the probabilities associated with it would no longer trigger a design inference. But that's just the point, isn't it? Namely, whether such a pathway exists in the first place. Miller, it seems, wants me to calculate probabilities associated with indirect Darwinian pathways leading to the flagellum. But until such paths are made explicit, there's no way to calculate the probabilities. This is all very convenient for Darwinism and allows Darwinists to insulate their theory from critique indefinitely. Over six years after Michael Behe made the bacterial flagellum the mascot of the intelligent design movement, Ken Miller has nothing more than the TTSS to point to as a possible evolutionary precursor. Behe and the ID community have therefore successfully shown that Darwinists don't have a clue how the bacterial flagellum might have arisen. Miller, however, wants more, namely for ID proponents to show that Darwinists don't have a prayer for the naturalistic origination of the flagellum. But as a good Roman Catholic, Miller must realize that no sinner is beyond the reach of prayer, not even the Darwinist. At any rate, prayer is not the issue. The issue is whether design does have a clue about the flagellum. The intelligent design community argues that it does. Miller doesn't like the argument, but don't think for a moment that he has anything equal or better.

Conflating ID with Interventionism:

According to Miller, intelligent design "requires that the source of each and every novelty of life was the direct and active involvement of an outside designer whose work violated the very laws of nature he had fashioned.... The notion at the heart of today's intelligent design movement is that the direct intervention of an outside designer can be demonstrated by the very existence of complex biochemical systems" Miller and I have discussed this criticism in public debate on several occasions. By now he should know better.

Intelligent design does not require organisms to emerge suddenly or be specially created from scratch by the intervention of a designing intelligence. To be sure, intelligent design is compatible with the creationist idea of organisms being suddenly created from scratch. But it is also perfectly compatible with the evolutionist idea of new organisms arising from old by a process of generation. What separates intelligent design from naturalistic evolution is not whether organisms evolved or the extent to which they evolved but what was responsible for their evolution.

Naturalistic evolution holds that material mechanisms alone are responsible for evolution (the chief of these being the Darwinian mechanism of random variation and natural selection). Intelligent design, by contrast, holds that material mechanisms are capable of only limited evolutionary change and that any substantial evolutionary change would require input from a designing intelligence. Moreover, intelligent design maintains that the input of intelligence into biological systems is empirically detectable, that is, it is detectable by observation through the methods of science. For intelligent design the crucial question therefore is not whether organisms emerged through an evolutionary process or suddenly from scratch, but whether a designing intelligence made a discernible difference regardless how organisms emerged.

For a designing intelligence to make a discernible difference in the emergence of some organism, however, seems to Miller to require that an intelligence intervened at specific times and places to bring about that organism and thus again seems to require some form of special creation. This in turn raises the question: How often and at what places did a designing intelligence intervene in the course of natural history to produce those biological structures that are beyond the power of material mechanisms? Thus, according to Miller, intelligent design draws an unreasonable distinction between material mechanisms and designing intelligences, claiming that material mechanisms are fine most of the time but then on rare (or perhaps not so rare) occasions a designing intelligence is required to get over some hump that material mechanisms can't quite manage. Hence Miller's reference to "an outside designer violat[ing] the very laws of nature he had fashioned."

As I've pointed out to Miller on more than one occasion, this criticism is misconceived. The proper question is not how often or at what places a designing intelligence intervenes but rather at what points do signs of intelligence first become evident. Intelligent design therefore makes an epistemological rather than ontological point. To understand the difference, imagine a computer program that outputs alphanumeric characters on a computer screen. The program runs for a long time and throughout that time outputs what look like random characters. Then abruptly the output changes and the program outputs the most sublime poetry. Now, at what point did a designing intelligence intervene in the output of the program? Clearly, this question misses the mark because the program is deterministic and simply outputs whatever the program dictates.

There was no intervention at all that changed the output of the program from random gibberish to sublime poetry. And yet, the point at which the program starts to output sublime poetry is the point at which we realize that the output is designed and not

random. Moreover, it is at that point that we realize that the program itself is designed. But when and where was design introduced into the program? Although this is an interesting question, it is ultimately irrelevant to the more fundamental question whether there was design in the program and its output in the first place. We can tell whether there was design (this is ID's epistemological point) without introducing any doctrine of intervention (ID refuses to speculate about the ontology of design)

Intelligent design is not a theory about the frequency or locality at which a designing intelligence intervenes in the material world. It is not an interventionist theory at all. Indeed, intelligent design is perfectly compatible with all the design in the world being front-loaded in the sense that all design was introduced at the beginning (say at the Big Bang) and then came to expression subsequently over the course of natural history much as a computer program's output becomes evident only when the program is run. This actually is an old idea, and one that Charles Babbage, the inventor of the digital computer, explored in the 1830s in his *Ninth Bridgewater Treatise* (thus predating Darwin's *Origin of Species* by twenty years).

Let's be clear, however, that such preprogrammed evolution would be very different from evolution as it is now conceived. Evolution, as currently presented in biology textbooks, is blind -- nonpurposive material mechanisms run the show. Within this naturalistic conception of evolution, the origin of any species gives no evidence of actual design because mindless material mechanisms do all the work. Within a preprogrammed conception of evolution, by contrast, the origin of some species and biological structures would give evidence of actual design and demonstrate the inadequacy of material mechanisms to do such design work. Thus naturalistic evolution and preprogrammed evolution would have different empirical content and be distinct scientific theories.

Of course, such preprogrammed evolution or front-loaded design is not the only option for the theory of intelligent design. Intelligent design is also compatible with discrete interventions at intermittent times and diverse places. Intelligent design is even compatible with what philosophers call an occasionalist view in which everything that occurs in the world is the intended outcome of a designing intelligence but only some of those outcomes show clear signs of being designed. In that case the distinction between natural causes and intelligent causes would concern the way we make sense of the world rather than how the world actually is (another case of epistemology and ontology diverging).

We may never be able to tell how often or at what places a designing intelligence intervened in the world or even whether there was any intervention in Miller's sense of violating natural laws. But that's okay. What's crucial for the theory of intelligent design is the ability to identify signs of intelligence in the world -- and in the biological world in particular -- and therewith conclude that a designing intelligence played an indispensable role in the formation of some object or the occurrence of some event. That is the start. Often in biology there will be clear times and locations where we can say that design first became evident. But whether that means a designing intelligence actually intervened at those points will require further investigation and may indeed not be answerable. As the

computer analogy above indicates, the place and time at which design first becomes evident need have no connection with the place and time at which design was actually introduced.

In the context of biological evolution, this means that design can be real and discernible in evolutionary change without requiring an explicit "design event," like a special creation, miracle, or supernatural intervention. At the same time, however, for evolutionary change to exhibit actual design would mean that material mechanisms were inadequate by themselves to produce that change. The question, then, that requires investigation is not simply what are the limits of evolutionary change, but what are the limits of evolutionary change when that change is limited to material mechanisms. This in turn requires examining the material factors within organisms and in their environments capable of effecting evolutionary change. The best evidence to date indicates that these factors are inadequate to drive full-scale macroevolution. Something else is required -- intelligence.

Miller's Foray into Theology:

Miller concludes his essay by remarking, "The struggles of the intelligent design movement are best understood as clamorous and disappointing double failures -- rejected by science because they do not fit the facts, and having failed religion because they think too little of God." As for intelligent design's rejection by science, Miller's claim needs to be adjusted as follows: "rejected by a naturalistic construal of science because it does not fit a dogmatically held theory, to wit, Darwinism." As for intelligent design's rejection as bad theology, Miller would do well to review his own theology. In *Finding Darwin's God*, Miller (1999, 241) writes: "The indeterminate nature of quantum events would allow a clever and subtle God to influence events in ways that are profound, but scientifically undetectable to us. Those events could include the appearance of mutations, the activation of individual neurons in the brain, and even the survival of individual cells and organisms affected by the chance processes of radioactive decay." As far as Miller is concerned, this presumably is good theology. And as an "orthodox Catholic" (Miller referred to himself that way in the PBS evolution series that aired September 2001), Miller presumably accepts full-blown divine intervention in salvation history even if he repudiates it in natural history. Indeed, what are we to make of this Jesus fellow, who walks on water, multiplies loaves and fishes, gets born of a virgin, and then resurrects after being crucified?

There's an obvious difficulty with Miller's theological criticism: Why is it necessary to a good theology that a designing intelligence act in ways that are "scientifically undetectable to us." It's certainly prudent, as a matter of maintaining one's respectability in Western intellectual high culture, to assert the scientific undetectability of design (those crazy fundamentalists, after all, need to be kept at bay). But as a matter of good theology, which presumably means a theology that is at once logically coherent and faithful to the Christian tradition, why in the world should "scientific undetectability" be an issue at all? The detectability of something, after all, does not undercut its freedom of expression. That, after all, is Miller's main concern, that intelligent design will somehow undercut the freedom of God and creation to be creative. But that intelligent design, by

stressing scientific detectability, should undercut divine freedom doesn't follow at all. What scientific detectability addresses is not the freedom of God or creation, but the completeness of material mechanisms and natural laws to characterize everything that happens in nature. Now that completeness is not part of "good" theology. In fact, when Friedrich Schleiermacher, the father of liberal theology, naturalized Christian theology in this way (cf. Schleiermacher's emphasis on "the system of nature" in his treatise *The Christian Faith*), it was as a concession to the monism of Spinoza on the one hand and the determinism of Newtonian physics on the other, both of which are themselves problematic.

The charge that ID is bad theology, just as the charge that it is bad science, is a convenient fiction. In the PBS series to which I just adverted, Miller called himself both an "orthodox Catholic" and an "orthodox Darwinian." If you are an orthodox Darwinian, then the best theology you can come up with is probably something like what Miller sketches in *Finding Darwin's God*. But intelligent design is making clear that there's no reason to be an orthodox Darwinian and thus no reason to accept a theology built on Darwinian foundations. At any rate, good theology did not come of age with Darwin. Far from it. Darwinism does just fine without any theology whatsoever. When Richard Dawkins (1986, 6) writes that Darwin made it possible to be an intellectually fulfilled atheist, he's not far from the master, who thought that no knowledge about God of any sort was possible. Miller's forced marriage of Darwinism and theology is an unhappy one. In the name of good theology, intelligent design is only too happy to preside over their divorce.

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