Design: What Scientific Difference Could It Make?

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The claims that intelligent design theories are not legitimately scientific and that such theories can carry no genuinely scientific content represent conventional anti-design wisdom. However, actual supports for such claims come to remarkably little and tend to implode under scrutiny. Furthermore, demands confronting design theories are often arbitrarily restricted to the realm of direct empirical consequences. The precise surface-level empirical upshot of design theories is, I think, still relatively minimal. But the directly empirical level does not exhaust the substance of science, and design theories may bring to science deeper cognitive richness, broader conceptual resources, and more substantive anchors than a purely (methodologically) naturalistic science can achieve.

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Intelligent design has become a focus of hot—even blistering—debate. Not all critics agree on the exact nature of the outrage it perpetrates, but high on the list of charges are (1) that the very concept of intelligent design when applied to nature itself inescapably constitutes reference to supernatural design—a reference whose illegitimacy, some apparently feel, is far beyond dispute, and (2) that even were the concept of intelligent design legitimate, in some philosophical sense, it would simply have no empirical, scientific bite.

In what follows, I wish to do three things. First, I will argue that in principle the concept of intelligent design can be legitimately applied to what we would ordinarily take to be *natural* phenomena. Second, I will explore some issues concerning the *recognition* of design. Third, I will argue that although design may not cut the swath its advocates claim for it, it does have scientifically interesting potential. Whether that potential is (or is likely to become) actual, I will not address.

I will proceed by glossing the most popular critiques of design in each of the three areas, then briefly explore resources available to design advocates in those areas.

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Legitimacy—The Principial Question

1. *Definition.* The concept of intelligent design is frequently ruled out of the natural sciences on the grounds that if the concept is applied to nature, the only relevant designer would have to be some supernatural being, reference to whom is scientifically forbidden. This prohibition is sometimes justified by appeal to some definition or rule of science—typically methodological naturalism (MN), which is frequently characterized as follows:

> The view that nature is the whole of reality (philosophical naturalism) may or may not be correct (science itself simply takes no position), but since science cannot deal with the supernatural, it is an essential methodological principle of science that science must proceed *as if* philosophical naturalism is correct.[1]

In practice, MN involves a provisional acceptance of a *separability* thesis—an assumption that the natural realm can be separated from the immaterial (e.g., mind, God) at some level below which it can be treated as autonomous (in a scientifically relevant sense) given suitable structural and organizational principles, or that there is some level of behavior and organization in nature below which mind and agency are not scientifically relevant. *Design*, on this view, is suspect since it represents a potential denial of separability. But separability is

a substantive thesis whose truth and essentiality to science require argument. And even were it true, determining where the relevant level(s) lies would be scientifically crucial, perhaps nontrivial, and might itself require recognition of the presence or absence of mind or agency involvement. But if science could do that, the case for barring design would be substantially undercut.

Although MN may be a valuable strategic principle, elevating it to a definitional principle generates nasty problems. Should it turn out that naturalism does *not* constitute the whole relevant story of some scientific domain, then commitment to MN will guarantee that the scientific picture generated in that domain would inescapably be either incomplete or simply mistaken. In short, if nature does not bow to our stipulations, science risks difficulty.

Furthermore, attempts to triumph definitionally are complicated by the fact that no one *has* a compelling definition of *science*, that most demarcation attempts are deep in some twilight zone, and that attempts to settle substantive issues via a priori definitional trumping do not seem consistent with the image of science even most scientists maintain.[2]

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2. *Unfalsifiability*. It is widely claimed that design hypotheses are unfalsifiable and consequently scientifically illegitimate. Falsification of design hypotheses would indeed be a tricky business. Virtually any proposed empirical criterion for nondesign could be deliberately contrived by a resourceful designer. Thus, attempts to *prove* that a specific phenomenon was not designed would be virtually hopeless.[3]

More generally, this criticism frequently rests on the idea that design attempts are scientifically empty, being reconcilable with absolutely everything. This hyperflexibility charge, however, requires caution. There have been multitudinous novel empirical discoveries but relatively few theoretical revolutions, which suggests that even respectable scientific theories are flexible enough to adjust to a wide range of unanticipated phenomena. Even in cases where the alleged novel empirical phenomenon is subsequently scientifically repudiated (claims for its very existence being abandoned), during the initial period of provisional acceptance there may even be *multiple* theoretical proposals for accommodating it within a reigning theory.[4]

Could there be evidence against design adequate for scientific purposes? I see no reason why not. If we had empirical evidence that the history of human evolution really was a random "drunk walk," then although absence of design would not be *entailed*, the case for lack of design (in that specific matter) would seem to be *scientifically* defensible. That is not only adequate but perhaps as good as could be demanded.[5] In any case, unfalsifiability does not imply the absence of relevance and impact.

3. *Nonpredictiveness*. Closely intertwined with the unfalsifiability issue is a charge that intelligent design is nonpredictive. This issue, however, is not so straightforward as often thought. First, it is generally recognized that scientific theories make predictions only in conjunction with other inferential resources—boundary conditions, auxiliary hypotheses, instrumentation theories, etc. Second, different scientifically-essential principles operate at different levels in a conceptual hierarchy within science, at different degrees of removal from the empirical trenches.[6] What connection a conceptual component should have with empirical predictions is partially a function of the level upon which it operates. Further, science unavoidably rests in part upon a conceptual matrix of deep metaphysical presuppositions. Such principles must generate *some* payoff in the broader scientific picture, but that payoff is not always so simple as particular identifiable empirical predictions. Design theories *might* find their legitimacy deeply enough within the structure of science to make demands for specific empirical predictions inappropriate. Such theories might, for instance, constitute key parts of a scientific conceptual matrix whose payoff is more subtle, more contextual.[7] Thus, what does or does not count as a fatal difficulty for design theories will depend upon the exact nature and level of such theories.[8]

Although space precludes discussion here, it is worth noting that virtually every accusation in this area raised against design theories applies equally to the uniformity of nature—a principle whose scientific propriety few would care to challenge.[9] And although other principial objections to design theories in science also have been raised, I think that it can be shown that none of the objections withstand scrutiny.[10] In fact, there are considerations which suggest some degree of legitimacy for design theories. One cluster of such follows briefly.

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4. *Aliens.* The concept of intelligent *alien* design is certainly scientifically legitimate, and that fact has implications often not recognized. There is no rule in science requiring either that life on earth began here or that theories concerning the origin of life on earth be restricted in that manner. In fact, a number of prominent scientists (e.g., Fred Hoyle, Francis Crick) have argued that life could not have arisen naturally under prevailing early earth conditions and time constraints, and that life consequently had to have come here from elsewhere. It is at least possible in that case that life was specifically engineered for earth conditions—that life as *we* know it is an artifact of intelligent design and agency.

There is nothing inherently unscientific in that view nor in the idea that if life as we know it is a designed artifact, then it is in principle possible for us to discover that fact through empirical investigation. This line of reasoning can be extended further. It has been suggested by various physicists (e.g., Andrei Linde, Edward Harrison) that technologically advanced cultures might develop the capability of generating bubble universes. Advanced technology might even allow specification of "natural" physical parameters inside such universes—generating what could appear *inside* such a universe to be "cosmic fine tuning" or possibly even a deliberately constructed message.[11]

There seems little a priori reason for thinking that creatures developed within such a universe (perhaps as deliberately intended results of specification of the bubble's parameters) would necessarily be unable to determine the artifactual status of their universe. Prohibitions against scientific application of the concept of design either to phenomena within what we normally think of as nature, or to that "nature" itself, seem thus mistaken. So long as the cosmic artisans are natural (in some broader sense), the idea that our universe (our "nature") is intelligently designed and that empirical investigation can reveal that fact is in principle scientifically legitimate.[12]

5. *Extensions.* Two related considerations extend the implications even further. First, it is commonly observed that the *identity* of the artisan(s) should make little difference. In the movie *2001*, recognition of the monolith as designed was independent of any knowledge of the identity, character, or intentions of the designer(s) (or of the means of production). Indeed, we would have identified the monolith as designed even had its artisan been supernatural. It cannot be seriously maintained that one cannot admit within science that something is designed *unless* one knows or assumes that the designer is not supernatural. Even *if* it is illegitimate to consider the supernatural within science, obviously designed phenomena (e.g., a bulldozer) could still be legitimately recognized *as* designed even *if* their designer was in fact supernatural.

Second, sealing off science from recognition of the supernatural may not be trivial. Whether an *investigation* is scientifically legitimate is surely independent of what ultimate results the investigation generates. (Otherwise, one would not know whether to apply to NSF or NEH until *after* one's investigation were completed—a clearly intolerable situation for everyone concerned.) One possible outcome of relevant investigation would be that the universe (or life as we know it, etc.) was an artifact, and that the artisan(s) was/were technologically advanced natural beings. The *investigation* could surely be scientific, and if the identity of the artisan(s) as natural, alien, etc. were legitimately scientific, then at least according to Popperians, the latter part of that conclusion would have to be empirically falsifiable—i.e., it would have to be in principle empirically demonstrable that the artisan(s) was/were *not* technologically advanced natural beings. Were that shown, options concerning the identity of the artisan(s) would be seriously restricted. Indeed, the conclusion that the artisan(s) was/were *super*natural would be very close to entailed. (That would, of course, constitute an additional challenge to the separability thesis. One related concern will emerge later.)

I will not pursue this legitimacy issue further here.[13] But if considerations like those above do not establish the scientific in-principle permissibility of intelligent design theories, they at least suggest that the opposite conclusion is far from unchallengeable.

Recognition—The Practical Question

Such legitimacy would be of little significance were there no reliable means of detecting or recognizing design (at least sometimes) when it was manifested. What design-recognition procedures are available to us, and could any of them apply even in principle to natural phenomena?

1. *Counterflow and artifacts*. We tacitly recognize design almost non-stop in the normal course of things—in physical, conceptual, and behavioral artifacts. Design recognition is essential even in various sciences, from the social to such semi-hard sciences as anthropology, the Search for ExtraTerrestrial Intelligence (SETI), and some forensic sciences. However, the recognition process in virtually all relevant instances rests upon recognition that some aspects of the phenomenon in question exhibit *counterflow*—characteristics which nature unaided by agency does not, would not, or even could not produce. SETI, for instance, looks initially for signals of a type, pattern, or frequency not likely attributable to natural processes. Attempts to understand Stonehenge began with the trivial recognition that it was an artifact and not a product of natural processes. That is the basic pattern of familiar cases of design recognition—a preliminary recognition of counterflow and artifactuality.[14]

Our typical dependence on counterflow generates a potential difficulty with attempts to recognize design in or of *nature*, since absence of familiar counterflow and artifactuality seems to be precisely what characterizes nature *as* nature—things we find in nature are exactly what nature does, would, and can do. Could we then ever recognize design in nature?[15]

2. *Cognitive resonance*. Design recognition does not depend solely (or perhaps at all, in some cases) upon recognition of counterflow. What signals design—as opposed to just artifactuality—is that designed phenomena typically manifest some characteristic that resonates with our cognition. Even the most ordinary cases of design involve more than merely something nature would *not* do. Being deliberately agent-generated, they typically involve something that an agent, a mind, *would* do. That is the heart of the concept of design. And that characteristic in principle can be recognized independent of recognition of counterflow, and can exist independent of counterflow itself.[16]

3. *Designer psychology*. But recognition of design in nature solely on the basis of cognitive resonance seems problematic. Surely what an agent or a mind *would* do depends crucially on the type of agent/mind in question. And once outside the realm of *human* design, we apparently have no experience whatever, much less a basis for a respectable induction. What, for instance, might be the standard Alpha Centaurian psychological profile? What aims and values and concepts might such creatures have? Would *any* of those things overlap with ours? Or how would we know what a *supernatural* agent would be inclined to do, or what sorts of design an utterly infinite mind would find appealing?[17] These are, of course, question-types rooted in Hume and which flowered in Darwin.[18]

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Those are serious, but not necessarily fatal, questions. For one thing, there might be common constraints governing any natural intelligence, or any physically-based intelligence. Indeed, SETI research tacitly employs that assumption in determining what microwave bands to pay particular attention to. For example, arguments for the so-called "waterhole" search principle involve assumptions concerning not only alien capabilities, but alien broadcast band selection strategies.

With a supernatural designer, however, such constraints might be absent. But within Judeo-Christian theology there are further potentially significant resources. First is the doctrine that humans are created in the image of God. The exact character and implications of that doctrine are disputed, but to the extent that it bears upon structures of human cognition, it may provide a basis for recognition of at least some instances of supernatural design. (In fact, science itself depends upon nature's intelligibility to us, which may in its turn depend upon structures in our cognition imaging structures in God's wisdom which he built into the creation.) Second is the traditional view that humans were created to be knowing beings. That opens the *possibility* of our having inbuilt resources allowing recognition of design, whether that design be human and alien design involving counterflow and artifactuality, or supernatural design in nature involving neither of those properties.[19]

4. *Design-recognition faculties*. Is there reason to think that we do have such capabilities? Oddly enough, Darwin

himself, in the last year of his life, testified that a conviction of design in nature "often comes over me with overwhelming force …"[20] It was a conviction that *happened* to him—not an inference or choice or anything else of his own doing.

The contemporary biologist Francis Crick sees this intuitive tilt toward involuntary design convictions as pervasive and powerful enough to necessitate posting warnings for biologists. He cautions: "Biologists must constantly keep in mind that what they see was not designed, but rather evolved."[21]

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The idea that we have an inbuilt design-recognition ability can be found in William Whewell and is mentioned in David Hume, but it is most explicitly explored in the eighteenth-century Scottish Common Sense philosopher Thomas Reid. According to Reid, our basic recognition of design (in particular, of certain properties as marks or signs *of* design) does not involve either prior experience, induction, or inference of any sort, but is ultimately involuntary and *perceptual*, roughly paralleling ordinary sensory perception. As a consequence of the constitution of our nature, certain sensory events trigger in us particular cognitive states, including not only direct recognition of and convictions concerning trees and other humans, but also recognition of and convictions concerning design.

Although I will not go into it here, I think that Reid's view is plausibly defensible.[22] He at least *seems* to be right that in our ordinary, everyday recognition and identification of human design (spoons, chairs, space shuttles) we do not engage in inference, calculate probabilities, or anything of the sort. (I suspect that we have little *clue* as to what some of the relevant probabilities even are.)[23] In fact, we sometimes appear able to directly and immediately recognize design in objects wholly beyond our previous experiences, and we presume that we would recognize as designed at least some alien artifacts whose very categories lie outside the experiences of any human being. But if something like a Reidian view is right, then recognition of design might have a legitimate claim to being observational and (at least in this respect) to being potentially as legitimate in science—and as reliable—as are other perceptual matters.[24]

Differences—The Pragmatic Question

Suppose, then, that reference to design is in principle legitimate in "natural" science, and that we could in principle recognize some occurrences in nature were such present. Would it make any real difference to science? It might initially appear that it would not. Two sets of considerations follow.

1. *Inferences to/from design*. There are two categories of design inference that require separation: (1) inference *to* design; and (2) inference *from* design. Inferences *to* design involve moving from particular empirical data to the conclusion that the phenomenon in question is a result (directly or indirectly) of deliberate design. Such inferences would require something like bridge principles stipulating that the relevant empirical characteristics indicate designedness. Establishing such connections in certain situations is unproblematic—we do so routinely every day. Unfortunately, as noted earlier, the everyday clear cases typically involve counterflow, and counterflow is precisely what is systematically missing (or at least bitterly contestable) in the cases of interest in natural science. Significantly weakening any inductive case for the crucial bridge principles are the facts that (1) the familiar cases are without exception from the artifactual category and (2) that this artifactuality plays a significant role in design attribution in those familiar cases, whereas (3) the cases of interest (design in nature) are apparently outside the artifactuality category and lack that often crucial characteristic.

Inferences *from* design involve moving from design claims (whether presuppositions or conclusions) to other empirical matters (e.g., empirical predictions). Some such inferences are in familiar cases unproblematic. Others are much less secure, given that designers can act in surprising ways. Depending upon the designer's values, motivations, capacities, conceptions, interpretations of situations, theories, etc. (all the way up to worldviews), a designer may do any number of totally unanticipatable things. Thus, although recognizing design and (after the fact) making sense of design may be nearly trivial in some cases regardless of the designer's character, values, intentions, beliefs and so forth, *predicting* the shape of design activity in the absence of

significant knowledge of those things may be virtually impossible. Thus, inferences *to* design in nature seem problematic, and even if such design is simply granted, it does not seem to lead far scientifically.

2. *Gaps, non-gaps, and existence proofs.* If we look more specifically at instances involving design, the fact/presence of design often seems to be unconnected to any scientific leverage such instances generate. That contention may be supported as follows. Specific design cases seem to come in two varieties—with and without natural causal gaps in the production of the phenomena in question.[25] Let us discuss them in turn.

If we look more specifically at instances involving design, the fact/presence of design often seems to be unconnected to any scientific leverage such instances generate.

Gaps. Suppose that the first human landing on Mars was confronted with an undeniable Martian bulldozer—a clear case of design involving a natural causal gap, since nature's capabilities unaided by agency stop well short of producing bulldozers. Discovering this bulldozer, we would infer the existence of a suitable intelligence with suitable technical capabilities. We might even be able to infer various things about the designer(s) from the bulldozer. We also might acquire substantial technical and technological knowledge from examination of the bulldozer, and might even learn some new theoretical principles as well. However, except for matters closely linked to the fact of the gap (e.g., the existence of the artisans), nearly everything we would learn would depend on the mere *existence* of the bulldozer—not on either its designedness or its artifactuality. Suppose that by some wild freak of chance, random processes had produced that exact bulldozer, down to its very molecular structure. Whatever *processes* operated in the bulldozer, whatever *principles* its functioning exhibited—all would be exactly as manifest in the chance bulldozer as in the actually designed bulldozer, and anything that was there to be learned in the one would be there to be learned in the other. Beyond issues of mere artisan existence, whether the bulldozer is *designed* seems completely irrelevant on these specific counts.[26]

Non-gaps. Gapless design cases would seem to offer even less prospect of unique scientific fruitfulness. If there are no gaps, then whatever the phenomenon, there will be a natural explanation (at the immediate level) of its existence and its characteristics. The fact that it also was designed would offer no more insight into function, principles, or mechanisms than would its mere existence. Its existence and its operation would (back arbitrarily far) seem to be wholly explicable in mechanical (at least natural) terms. There might be features about it which implied the existence *ultimately* of an intelligence that designed it indirectly, but what *scientific* impact would that have? Design would seem to be simply an add-on layer. If there are no gaps, then aside from issues of ultimate origins, the "designed" conclusion would seem to have no *empirical* implications not already implicit in the very structure, governance, and course of nature itself.

As before, any such "natural" phenomenon could constitute an existence proof, but even more than before, *designedness* would seemingly play no role. Here is an interesting recent example. An astronomer concerned with observational-field limitations of X-ray telescope lenses read an article discussing the structure of lobster eyes (more generally, macruran eyes), and recognized it as a possible solution to the problem. Some X-ray telescope technology now being developed embodies lessons learned from phenomena—lobster eyes—which the researchers apparently did not need to see as designed in order to learn the relevant lessons from it.[27] Here again, it was an existence proof—not any inference from designedness[28]—which did the work.[29]

A Deeper Look

Perhaps this dismissal is a bit too quick and simple. Recall the earlier point that how conceptual components of science function and what demands might be legitimately made of them are not all of a kind. Unnuanced demands that the payoffs of incorporating design and related concepts into science be immediate and empirically specific may reflect insufficient appreciation of some of the philosophical complexities involved. But what other sorts of payoffs might design possibly offer? Following are several suggestions.

1. *Contextual embedding*. Christian theology played a significant (perhaps pivotal) role in the birth of modern science. The doctrines of creation and of divine voluntarism figured prominently in rational justifications of essential presuppositions—uniformity of nature, intelligibility of nature, necessity of observation, reliability of human sensory and cognitive faculties, permissibility of experiment, and the like. The idea of design was crucial—things that are designed are typically intelligible, embody consistency and coherence, and generally must be empirically examined to determine what the actual structure is. Indirectly, then, design theories would tie into a deeper

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legitimation of science's presuppositions than is otherwise available and might thus afford one a worldview which was more organically unified on its upper levels. Such unification, as a form of consilience, sometimes even has evidential force.

2. *Perspectives*. Taking nature (or subsystems) to be designed could also generate a substantively different perspective on reality. Since science cannot even in principle avoid taking some of its character and some of its conceptual resources from the larger conceptual matrix within which it is located, that *could* have significant scientific consequences. Deep principles concerning the nature of reality—including design—can affect such scientifically consequential matters as what sorts of theories might be considered legitimate, what sorts of conceptual resources are acceptable, what sorts of proposals can be considered plausible, what sorts of investigative questions are asked, what sorts of patterns in phenomena are even noticeable let alone considered genuine and revealing, what sorts of approaches are seen as legitimate and potentially fruitful, and what criteria proposed answers must meet.[30] As a broad example, think of the profound historical scientific consequences of replacing organic metaphors in science with machine metaphors.[31]

3. *Understanding*. On some views, *understanding* relevant truth is the deepest aim of science. Suppose that the fact of something being designed did not entail or predict any other empirical matters at all. That something is a product of design is nonetheless a substantive and upright bit of information about it even if knowing that it was designed did not help us understand its purpose, its history, its origin, its means of production, its producers, its operation, its incorporated principles, or much of anything else. Saying exactly why and how that is scientifically interesting is not easy. Still, any scientific investigator who managed to overlook the designedness of, say, a Martian diesel bulldozer would be inept. Surely exactly the same must be said about nature. Even were the designedness of nature to have no further *scientific* implications, the fact of that design would nonetheless be a legitimately scientifically interesting fact, and one which ought not be overlooked.[32]

4. *Existence*. Genuine design—with or without gaps—would imply the existence of a designer(s).[33] If (e.g., in a Hoyle or Crick scenario) it appears that perfectly natural aliens designed and produced life as we know it, then that would be scientifically important and could have significant further implications for research questions, aims, strategies, and permissible conceptual resources. But bare facts just concerning existence, even without such implications, are neither trivial nor scientifically irrelevant. Even if the *only* thing we learned was that such aliens (had) existed, this mere existence would have as much *scientific* propriety as the establishment of the existence of some new phylum on earth (as in the recent lobster lip case involving *Symbion pandora*), or the existence of some (any) lifeform on Mars. After all, the discoverers of *S. pandora* did not have to submit their reports to *The Journal of Philosophy*. Were it established that "normal" aliens (and not supernatural beings) had generated the bubble universe we inhabit, that absolutely would not be a matter of indifference to scientists—either qua scientists or qua human beings. And if empirically-based investigations began suggesting that the bubble-designing agent was not merely (natural) alien, it is not completely obvious why that could properly be of interest to scientists only *qua* human beings and not *qua* scientists.[34]

It will, of course, be claimed that science *could not* establish the latter. Although it should not be forgotten that some are unprepared to admit *any* limitation on science,[35] those who do stipulate naturalistic limits for science risk forcing science to miss—or worse, to deliberately ignore—what would be the biggest scientific story ever.

5. *Conceptual space*. Being open to design offers a further possible scientific benefit.[36] Design theories can allow conceptual *space* for gaps in the course of nature. There may or may not actually be such gaps (that is an empirical question, and design as such cuts neither way here), but (paralleling an earlier point) if there are gaps, then any science which denies their existence will of necessity be either incomplete (offering no relevant explanation of some aspects of the phenomenon in question) or mistaken (offering a full, gapless explanation where a gap in fact does exist). Some design theories could permit scientific recognition of gaps for what they

are, whereas blanket prior rejection of the possibility of design—and with it, the practical possibility of gaps—would deprive science of that flexibility.

Design theories can allow conceptual space for gaps in the course of nature.

That would have consequences for the alleged "self-correcting" nature of science. In cases where the truth of the matter is non-natural, even were some favored naturalistic theory discovered to be false, science would be forced by methodological naturalism to consider only naturalistic replacements—all of which would *ex hypothesi* also be mistaken. Furthermore, a doctrinaire commitment to methodological naturalism conjoined with a commitment to the position that the picture produced by science is correct and potentially complete very nearly entails *philosophical* naturalism. Of course, many religious believers explicitly deny the completeness of science, contending that wherever the supernatural is concerned science *should* fall silent. But to fall silent where it should and to speak where it should, science will need some means of identifying if, when, and where supernatural activity may be occurring (or has occurred). If science, however, can identify ifs, whens, and wheres of supernatural activity, then those cases for excluding design which rest on claims that science cannot recognize the supernatural even in principle, are thereby undercut. Unless relevant boundaries are simply stipulated arbitrarily or a priori, making a real *case* for some version of the separability thesis is going to be unavoidable for strict methodological naturalists.

6. *Reverse engineering and tenacity.* One of the major pragmatic objections to design theories is the worry that scientists (being a lazy, depraved lot) would take the easy way out in the face of scientific difficulty, would appeal to divine agency, and thus would never discover material solutions even when there were such. They would simply quit too soon.

This is a legitimate concern, and was expressed at least as early as the 1600s, in the works of both Bacon and Boyle.[37] But failure to realize when it *is* time to quit is problematic as well. Crop-circle enthusiasts who reject explanations involving human pranksters and are holding out for alien activity evidently do not know when to quit. Erstwhile inventors of perpetual-motion machines (who accuse physicists of accepting the Second Law merely as a lazy way of avoiding the hard work of inventing perpetual motion) have also fairly clearly not learned when to quit. If life on Mars ultimately originated from microbes inadvertently carried to Mars by NASA probes, far future Martian scientists trying to figure out exactly how life spontaneously originated on Mars by chemical evolution will need to learn when to quit—when to give up on that research program. And if Hoyle, Crick, and others are correct, biologists who are still trying to figure out how life emerged from nonlife under early earth conditions in the time available, have failed to learn when to quit. Openness to design would permit recognition and flexibility, *were such warranted*, concerning when to quit—when to abandon degenerating research programs.

If science were pursued within a design conceptual context, then—if the designer were God—science literally would involve, as Kepler allegedly put it, "thinking God's thoughts after him."[38] Science would in a sense be an extended attempt at reverse engineering. As some others have noted, that reverse-engineering picture is suggestive.[39] In some cases involving human artifacts, design theories are exactly what *prevent* investigators from quitting too soon. Manufacturers (of cars, computers, chips, etc.) frequently disassemble their competitors's new products, looking for innovations, problem solutions, and the like. In that investigation, puzzling features are especially thoroughly investigated precisely *because* it is assumed that the product is designed and that the puzzling feature must be doing something significant, that it is not there simply by chance, for instance. One wonders if the ever-shrinking list of human vestigial organs would have gotten as large as it once was had researchers been working from a design perspective of humans as "fearfully and wonderfully made." The tag "functionless" might have been attached a bit less blithely in that case—as might the term "junk" to "DNA."[40]

7. *Empirical ground level*. Design has not been scientifically completely barren even at ground level. Much of the data upon which Darwin built his case had been generated by investigators pursuing design conceptions. Concerning the allied concept of teleology, historian of science Timothy Lenoir recently observed:

> Teleological thinking has been steadfastly resisted by modern biology. And yet, in nearly every area of research biologists are hard pressed to find language that does not impute purposiveness to living forms.[41]

But resisted or not,

> [In early nineteenth century Germany] a very coherent body of theory based on a teleological approach was worked out, and it did provide a constant fertile source for the advance of biological science on a number of different research fronts.[42]

John Hedley Brooke cites various other examples.[43] And Harvey famously discovered circulation of the blood partly as a result of the conviction that certain structures in blood vessels were there for *some* reason. Such payoffs

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have not been confined to biology. Fermat's (and later Maupertuis's) principle of least action (and its descendant Lagrangian and Hamiltonian formulations) seems to many straightforwardly teleological. Yet Max Planck claimed:

> Amid the more or less general laws which mark the achievements of physical science during the course of the last centuries, the principle of least action is perhaps that which … may claim to come nearest to [the] ideal final aim of theoretical research [i.e., to "condense all natural phenomena which have been observed and are still to be observed into one simple principle …"].[44]

Here Planck has singled out something carrying at least the distant whiff of design and intent as coming closer to the ideal of science than does any of its competitors.[45] Indeed, the whiff may not be all that distant. Elsewhere, Planck says:

> [W]hat we must regard as the greatest wonder of all, is the fact that the most adequate formulation of this law creates the impression in every unbiased mind that nature is ruled by a rational, purposive will.[46]

On the other hand, design hostility has sometimes interfered with data acceptance and theory advance. For instance, just as some resisted Big Bang theory because it looked too much like a creation, some may resist fine-tuning empirical data because conceding genuine knife-edge fine tuning threatens to stick one with deliberate supernatural planning as the only plausible explanation.[47]

Present Prospects

Does science need to explicitly acknowledge design theories at this point? I do not know the answer to that question. But it may be that science already *implicitly* does so. Science presumes a cosmos which is uniform, coherent, and intelligible, a universe in which beauty and elegance can be important markers of theoretical promise.[48] Those are arguably characteristics which any science-permitting cosmos would *have* to have, are plausible characteristics of a world a mind would plan, and are characteristics which, in the absence of a planning mind, must be either reduced to subjective human projections or left to hang implausibly in midair as "brute." That is why physicist and author Paul Davies (who is not a believer of any sort, so far as I know) recently remarked:

> Science began as an outgrowth of theology, and all scientists, whether atheists or theists … accept an essentially theological worldview.[49]

If Davies is right—and I think he is—then why do so many scientists fail to recognize that fact? Why have *anti*-design commitments played such a prominent role, both in biology (e.g., in connection with the initial enthusiasm in some circles for Darwin) and in cosmology (in many-world theories embraced by some to circumvent fine-tuning arguments)?[50] Why are some, like Richard Dawkins, so hostile to design theories that they will assert that employing design theories is "cowardly and dishonest"—i.e., not merely a scientific failure, but a moral failure as well?[51]

I think that in some cases the answer involves deep religious matters.[52] But in other cases, it may be that the capital which science has gotten from theologically and design-shaped metaphysical principles wears the mask of the familiar, and that science (and many scientists) live off that capital without knowing its source—much as some contemporary ethics live off the capital of historical theistic ethics often without being aware of that fact. It is perhaps as Einstein once asked: "What does a fish know of the water in which it swims all its life?"

Although science operates de facto in a deep design context and is suffused with the structuring presuppositions of that context, does science need the sorts of overt empirical ground level design theories recently advocated? Indeed, *can* design theories go beyond the contextual, the perspectival, the empirically indeterminate? Again, I do not know the answer to that question. However, I see no compelling justification for either hostility or prohibitions. Current intelligent design theories do not (it seems to me) have much to show at this point. But a remark of Andrei Linde's in a different context is intriguing:

> A healthy scientific conservatism usually forces us to disregard all metaphysical subjects that seem unrelated to our search. However, in order to make sure that this conservatism is re-

> ally healthy, from time to time one should take a risk to abandon some of the standard assumptions. This may allow us either to reaffirm our previous position, or to find some possible limitation of our earlier point of view.[53] ✦

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Notes

[1]"Methodological materialism," "methodological atheism," and "methodological naturalism" commonly are used interchangeably. Although perhaps not the first use of the term, the use in recent discussion of "methodological naturalism" probably originated with Paul DeVries. As Stephen Wykstra has pointed out, the standard characterization of methodological naturalism (MN) requires some adjustment to allow for the possibility that "nature" in a theistic universe and "Nature" in a non-theistic universe might be significantly different and that MN as a stipulation that science deal only with the natural realm thus would not necessarily be equivalent to a stipulation that science operate as if philosophical naturalism were true.

[2]Some standard conceptions of science would offer few resources to opponents of design. On anti-realist perspectives, the only plausible substantive objection would be if design concepts failed to be of practical use. That (as will emerge later) has not historically been the case.

[3]But exactly what that presumed fact would show is far from clear. Rigorous proof is, of course, not even on the scientific table—nor is rigorous falsification, for that matter. Closer to home, the parallel problem even in some cases of human design—as in deliberate attempts to conceal murder, arson, etc. by trying to make it look like a random accident or as an otherwise purely natural event—constitutes no difficulty whatever in generating scientifically legitimate design conclusions in anthropology, SETI, or even in confirming other cases as deliberate murder or arson. (That means that on a formal level, design cases would parallel what logicians call "half-yes machines.") In any case, it should not be forgotten that unfalsifiability does not imply inconsequentiality. Thoroughgoing paranoia is probably strictly unfalsifiable to its victims, but (like "bliks" in discussions of an earlier era) makes a profound difference. Similarly, uniformity of nature is probably strictly unfalsifiable, but is obviously not devoid of impact in science.

[4]For example, see the polywater case in Michael Friedlander, *At the Fringes of Science* (Boulder: Westview, 1995), 78.

[5]Of course, *establishing* that the path in question is a drunk-walk or that there is no design-relevant direction would not be trivial. In fact, it would encounter a problem frequently pinned on some design advocates—that being a dependence on "arguments from personal credulity," i.e., that we cannot identify a direction does not necessarily establish the absence of such direction. In the present case, the problem is compounded by the fact that the randomness of the walk would probably have to be established in part by reference to deep historical phylogenetic dead ends linked in specified ways to other evolutionary paths.

[6]This hierarchy climbs (roughly) from empirical data through theories (having varying degrees of theoreticity) through (among other things) axiological principles, principles concerning what concepts were or were not permissible, and on finally to metaphysical and even worldview matrices. For further discussion, see e.g., Stephen Wykstra, "The Interdependence of History and Philosophy of Science" (Ph.D. diss., Pittsburgh, 1978).

[7]Of course, there is a consequential tradeoff here. The further up the hierarchy design conceptions operate, the less rigid will be any connection between such concepts and empirical data, and the less stringent the empirical demands that can be made upon such concepts. On the other hand, the further up the hierarchy design operates, the less directly will empirical cases substantiate design principles. Thus, what a design theory might gain in immunity, it might lose in immediate empirical substance.

[8]But suppose that more specific predictive demands were appropriate. It certainly does not seem to be true that design theories are *inherently* non-predictive. If we know or believe that some subsystem S of some object is designed for some purpose or function, we can often predict some things concerning the existence and characteristics of correlated entities or other subsystems. (Or if we know anything about the tendencies of the designer, we could make even counterfactual predictions concerning how the designer would or might design in specified possible cases.) It might turn out that the specific design theories associated with contemporary design advocates make no requisite predictions, but that is simply a failure of local theory—not a principial problem. See my *Nature, Design and Science* (Albany: SUNY, 2001) for further discussion. It is also worth noting that intelligent design theories are basically *agency* theories, and that when dealing—even as scientifically as we can—with agents, our theories are quite routinely severely limited in predictive power, although often (after the fact) explanatorily quite powerful. I have made this point elsewhere, as has Bill Dembski.

[9]I have discussed this in some detail in *Nature, Design, and Science*.

[10]That is the thrust of chapter 9 of *Nature, Design, and Science*.

[11]In an interview with Rudy Rucker in *Wired* 3.07 (July 1995), Linde said:

> If I create an inflationary universe with a small density, I can prepare the universe in a particular state … [I]f I am preparing a universe in some peculiar state, I can send [a] message encoded in the laws of physics. … Let us imagine that someone made our universe as a message. … To send a long message you must make a weird universe with complicated laws of physics. … The only people who can read this message are physicists. Since we see around us a rather weird universe, does it imply that our universe was created not by God, but by a physicist-hacker? I do not entirely think of this possibility as a joke.

And John Horgan describes this speculation by Linde:

> [P]erhaps the [alien] engineer could manipulate the seed of preinflationary stuff in such a way that it would evolve into a universe with particular dimensions, physical laws, and constants of nature. In that way, the engineer could impress a message of some sort onto the very structure of the new universe. In fact, Linde suggested, our own universe might have been created by beings in another universe, and physicists such as Linde, in their fumbling attempts to unravel the laws of nature, might actually be decoding a message from our cosmic parents (John Horgan, *The End of Science* [New York: Broadway, 1996], 101).

Some ID advocates, e.g., Walter ReMine, have also argued for a "message" reading of some aspects of nature.

[12]There might, of course, be all sorts of nasty problems in pursuing such investigation (e.g., problems with design recognition), but it does not appear that those are of necessity *principial* problems.

[13]I have done so elsewhere in *Nature, Design and Science*, chap. 10.

[14]In fact, when presumed counterflow turns out to be naturally explainable, attributions of design often disappear. A nice example is the case of Jocelyn Bell Burnell's discovery of quasars, the first such source being initially (semi-humorously) informally designated "LGM-1" (Little Green Men-1), a designation which disappeared as natural mechanisms for such pulsed signals began to be proposed.

[15]Of course, if some things in nature *are* products of intelligent design, there is a broad sense in which those things *are* artifacts. (At least, without agent activity at some point in their history—perhaps primordial—they would not be as they are, or perhaps might not even be.) Thus the *formal* (although not the practical) problem would disappear. Substantial stretches of what we had previously

categorized as *natural* actually would belong in a different category. Suppose, for instance, that our cosmos was an artificially generated bubble universe. What we previously took to be natural actually would be artificial. *Counterflow*, in the relevant broader sense would have to be defined against the background of a hyperphysics or *ur*physics inhabited by the aliens involved. *Discovering* all that might be a nasty problem (to put it mildly), but the present *conceptual* problem would be removed. Of course, if nature is supernaturally created *ex nihilo*, then there is evidently no physics or *ur*physics background for some broader sense of counterflow to even be defined against. Nature would be an artifact, but not artifactual as distinct from natural.

[16]Critics of design theories, nearly without exception, in effect take design to be a theory of mere artifactuality rather than of design. Unfortunately, this is true of some design advocates as well.

[17]There are a number of complicated issues here. For instance, in prosaic cases, we sometimes recognize design through recognizing value. Many argue that value is subjective, nonscientific, socially induced, an accident of upbringing, etc. I do not think that this is true, but in any case, science itself requires application of certain values to operate at all—this is one of the major lessons of philosophy of science over the past several decades. Most scientists recognize not only epistemic values, but others, too—the values of truth, understanding, comprehension, as well as those of elegance, simplicity, consistency, and the like. Scientists committed to the legitimacy of such values—and whose science relies upon recognition and respect of such values—cannot very well reject design *merely* on the basis of its connections to value, nor upon its alleged tendency to import values into the scientific context.

[18]This cuts both ways, of course. If we cannot make defensible design judgments absent knowledge of the mind of the designer, then we cannot eliminate the possibility of design either. On the other hand, if the only evidence one has concerning a designer is through the designer's artifacts—i.e., if one only knows the designer's intentions, style, and so forth from empirical investigation of artifacts—then to the extent that design-based predictions depend upon having information concerning those intentions, style, etc., to that extent any predictive power which a design theory has will arise ultimately from the empirical data in question alone, and thus may in principle be available to empirical science *without* the mediation of any explicit design theory. Such theories might be heuristically useful, but logically, at least, they may be superfluous. In this connection, I think that it is significant that in Michael Behe's design proposal, the scientific work is done by the concept of irreducible complexity, whereas Behe's claim that irreducible complexity is a sign of *design* and the conclusion of design itself does (it seems to me, anyway) little if any scientific work at all.

[19]Herschel took the (then presumed) fact that atoms of a given type were all identical—reminiscent of the uniformity of objects mass produced by a stamping machine—as evidence of their artifactuality. Suppose that instead of mere uniformity we were to discover that every atom had a submicroscopic display (in flawless Hebrew) of a scriptural reference. And suppose that with our H. G.Wells-o-scope we established that nothing other than purely natural processes and events occurred in cosmic history back to the Big Bang. It would still be perfectly rational to identify that as designed despite the complete absence of counterflow, of any clue as to how it was done, etc.

[20]Quoted by the Duke of Argyll, "What is Science," in *Good Words* (April 1885): 236–45, p. 244.

[21]Francis Crick, *What Mad Pursuit* (New York: Basic, 1988), 138.

[22]More specifically, Reid takes the concept of *design* to apply most basically to *minds*. *Design* applies to other phenomena in, strictly speaking, only a derivative sense. I have discussed Reid's view in much fuller detail in "Perceiving Design," in Neil Manson, ed., *God and Design* (London: Routledge, 2003), 124–44.

[23]I have discussed this (as well as some objections to this line of thinking) in "Perceiving Design."

[24]In any conceptual pursuit, we ultimately have to simply depend upon some basic human intuitions. Even mathematics must rest at bottom on some apparently built-in intuitions concerning possibility and necessity and the like. And it does nothing toward escaping that fact to demand some *criteria* for such matters. Something at least similar seems to be true for sensory perception, recognition of the existence of other minds, and so forth. The demand for formal criteria for recognizing design seems to presuppose that design recognition does not have roots as deep as these other matters, and I am not sure exactly what the case for that presupposition is supposed to be. There are obvious disagreements over design, but in all these areas there are fuzzy zones and disagreements (concerning mathematical intuitions, concerning the conditions under which something may be said to be conscious and/or intelligent, etc.).

[25]We confront gaps all the time. A can of beans is something nature unaided by agency would not produce—there is a gap between nature's capabilities and the can of beans. So when confronted by the latter we fill the gap by appeal to human agency—a humans-of-the-gap explanation. Other gaps might require other gap measures. SETI, for instance, seeks phenomena which would require an aliens-of-the-gap explanation.

[26]Philip Corso, in *The Day After Roswell* (New York: Pocket, 1997), 120, claims that one military person poked his head into the (alleged) crashed Roswell craft, looked out through a port, and despite the fact that it was night found himself able to see everything outside quite clearly. This purportedly constituted crucial impetus to the idea of night vision goggles. The port was, of course, designed. But suppose that that precise sort of structure had evolved naturally and Darwinianly in a giant squid, and that someone preparing the squid head for display had looked out through the squid's eye lens just as the power failed—and had discovered herself seeing everything quite clearly. These two episodes could have had exactly the same consequences for triggering subsequent technological developments. Presence or absence of gaps in the lens production, and presence or absence of *design* would make no difference. In either case, the importance was the existence proof of a possibility. How it came into existence had no bearing upon that whatever. In some cases, discovery of a designed artifact might provide clues concerning methods of production, but in some cases it might not. For instance, Thomas Edison experimented with hundreds of different substances for light-bulb filaments. Given the wide and wild range of trials, one might almost think that he had seen a lightbulb, and via that existence proof knew—but knew *only*—that there was *some* sort of skinny thing which would work. Would anyone who really understood light bulb *theory* have tried, for instance, horsehair, as Edison did? Or settled upon bamboo splinters as the filament of choice, as Edison did? The suggestion of carbon filaments came from Edison's African-American assistant, Lewis Latimer.

[27]J. R. P. Angel, "Lobster Eyes as X-ray Telescopes," *Astrophysical Journal* 233 (1979): 364–73, M. Chown, *New Scientist* 150, no. 2025 (13 Apr 1996): 20. Space deployment of a lobster-eye telescope is apparently projected for 2009.

[28]There are numerous other cases of what is coming to be known as "biomimetics"—defined by the University of Reading Centre for Biomimetics as "the abstraction of good design from nature." See e.g., Jim Robbins, "Engineers Ask Nature for Design Advice," *New York Times* (Dec 11, 2001); and Delta Willis, "Naturally Inspired," *Natural History* 105, no. 2 (Feb. 1996): 53–5, especially p. 53. Recognition of similarity between things in nature and later human invention goes back some ways—see, e.g., J. G. Wood, *Nature's Teachings: Human Invention Anticipated by Nature* (London: Daldy, Isbister, 1877).

[29]There is a significant irony here. Some design advocates distinguish between "operation" science and "origin" science (the former involving only continuing lawlike regularities), and cite that distinction to undercut the scientific legitimacy of evolutionary theories of origins. But if that is a good distinction, then design might have no implications internal to operations science *unless* there were gaps and supernatural intervention.

[30]For further discussion of this general point, see e.g., Stephen Wykstra, "Should Worldviews Shape Science?" in Jitse van der Meer, ed., *Facets of Faith and Science* 2 (Lanham: UPA, 1996), 123–71, and Wykstra, "Religious Beliefs, Metaphysical Beliefs, and Historiography of Science," *Osiris* 16 (2001): 29–46.

[31]In fact, the idea of design has factored into not only resources and motivation for theorizing, but even into the courage to carry out such theorizing in specific directions. That could affect not only the *questions* one asked—which one might otherwise never consider—but the manner of pursuit. Along this general line, in the *Mysterium Cosmographicum,* Kepler claimed:

> [T]here were three things above all for which I sought the cause as to why it was this way and not another—the number, the dimensions, and the motions of the orbs. I have dared to carry out this search because of the beautiful correspondence of the immobile Sun, fixed stars, and the intermediate space with God the Father, the Son, and the Holy Spirit.

In similar fashion, Newton was emboldened by a doctrine of divine omnipresence to countenance something very like the otherwise proscribed concept of gravitational attraction at a distance.

[32]In light of such pervasive usefulness, orthodox anti-realism would dictate the embracing of design—albeit, of course, not as literal. Ironically, anti-realist heuristic employment of design poses some risk for design opposition, since instrumentally successful heuristics have a history of turning into realisms. For instance, Einstein's light-quantum idea was originally proposed heuristically. See e.g., Shapere, "Discussion: Doppelt Crossed," *Philosophy of Science* 55 (1988): 134–40, 138. Quarks constitute another physics example. Most scientists historically have thought that they were pursuing *truth*, and that has provided much more durable and effective motivation and inspiration than the pursuit of *as if*. And if design applies to us and our cognitive systems, we would have better grounds than otherwise available for thinking that there really is something to our typical conviction that our science aims at and sometimes captures genuine knowledge.

[33]I take "design" to mean "design," and not merely "apparent design" or "design-like" as Dawkins and some others do.

[34]There is some interesting history here. For instance, Newton, in the "General Scholium" says: "And thus much concerning God; to discourse of whom from the appearances of things, does certainly belong to Natural Philosophy," (Newton, *Principia*, Florian Cajori revision of Andrew Motte [Berkeley: California, 1962], 546). See also some of the "Questions" in the later editions of the *Optiks*.

[35]In his essay "Awesome versus Adipose," *Free Inquiry* 18, no. 2 (Spring 1998), Peter Atkins says: "Science gives us the prospect of full understanding, for it continues to show that, given time, there is no aspect of the world that is closed to its scrutiny and explanation." And that is not merely an in-principle competence. At the very end of his *The Creation* (Oxford and San Francisco: Freeman, 1981), Atkins says: "We are almost there. Complete knowledge is just within our grasp" (p. 127). It is worth noting that the view that science has no limits does not entail that religious principles are all false, but only that if they are true, science can establish them. That was, of course, the contention of natural theologians. In this connection, see Mikael Stenmark *Scientism* (Aldershot: Ashgate, 2001), 10.

[36]Of course, some benefits of this type could be achieved by employing design instrumentally, or heuristically similar to Dennett's contention that one has the best chance of beating a chess computer if one plays it *as if* it is intelligent. Even Dawkins, in attempting to describe a key feature of biological nature, resorts to counterfactual reference to an intelligent designer—see *Blind Watchmaker* (New York: Norton, 1987), 21. That may be defensible. But it is not clear why that move should be *needed* or even preferred.

[37]For instance, Boyle, in his 1688 *Disquisition* writes:

> a *Naturalist* [scientist], who would Deserve the Name, must not let the Search for Knowledge of *First Causes*, make him Neglect the Industrious Indagation of *Efficients* [emphasis his]

and Bacon in *De Dignitate et Augmentis Scientiarum* writes:

> For the handling of final causes in physics has driven away and overthrown the diligent inquiry of physical causes, and made men to stay upon these specious and shadowy causes without actively pressing the inquiry of those which are really and truly physical, to the great arrest and prejudice of science.

[38]This is widely attributed to Kepler, but I have been unable to confirm that the phrase appears in Kepler's writings.

[39]This point is made in D. Snoke, "In Favor of God-of-the-Gaps Reasoning," *PSCF* 53 (Sept. 2001): 152–8, note 2. The reverse engineering perspective may also bear upon "untestability" objections to design (closely linked to "unfalsifiability" objections). It has been argued by some that in reverse engineering one frequently does not begin with a hypothesized model, then test the model's predictions, but rather one traces mechanisms and circuits, identifies components, and otherwise tries from the object itself to figure out what the function and design is—models coming only later in the process.

[40]The point regarding "junk" DNA was made to me by one of this journal's reviewers.

[41]Lenoir, *Strategy of Life* (Chicago: University of Chicago Press, 1982), ix.

[42]Lenoir, *Strategy of Life*, 2.

[43]See his *Science and Religion* (Cambridge: Cambridge, 1991), especially chapters 1, 2, 4 and 6.

[44]This is from Planck's entry on the principle of least action in the encyclopedia *Kultur der Gegenwart* (1915), 68. This specific translation is employed by Jim Holt ("Least Action Hero," *Lingua Franca* [October 1999]: 68) and by Wolfgang Yourgrau and Stanley Mandelstam, *Variational Principles in Dynamics and Quantum Theory* 3rd ed. (Philadelphia: Saunders, 1968), 164. At least one other translator (Michael Stoeltzner) employs "probably" instead of "perhaps."

[45]Least action theories are not only predictive, but according to John Barrow and Frank Tipler, some, e.g., Euler, have argued that some problems which were practically intractable to mechanistic approaches could be solved via action principles. See Barrow and Tipler, *The Anthropic Cosmological Principle* (New York: Oxford, 1986), 150.

[46]Planck, "Religion and Natural Science," *Scientific Autobiography and Other Papers* (London: Williams and Norgate, 1950), 151–87, p. 177. The original essay was published in 1947. This passage was pointed out to me by David Van Baak.

[47]This possibility is hinted in John Leslie, *Universes* (New York: Routledge, 1989), 192. Of course, many-universe theories have been proposed as solving this "problem." I have argued that such solutions may do less than often thought—see my "Saturation, World-ensembles, and Design" [forthcoming].

[48]For some, e.g., Dirac, beauty may be the most important such marker. For others, e.g., Weinberg, Polkinghorne, it is at least essential.

[49]P. C. W. Davies, *Are We Alone?* (New York: Basic, 1995), 138.

[50]For a nice discussion of the biology case, see Adrian Desmond's *Politics of Evolution* (Chicago: University of Chicago Press, 1989).

[51]Dawkins leveled this charge in a talk titled "Unweaving the Rainbow."

[52]In a recent interview, Crick indicated that he had gone into science because of a distaste for religion, combined with a belief that science could be employed to undercut basic supports for religious belief. See Roger Highfield, "DNA Pioneers Lash out at Religion," *London Daily Telegraph* (March 24, 2003).

[53]"Inflation, Quantum Cosmology and the Anthropic Principle" forthcoming in *Science and Ultimate Reality: From Quantum to Cosmos* (essays in honor of John Wheeler's 90th birthday) ed. J. D. Barrow, P. C. W. Davies and C. L. Harper (Cambridge: Cambridge 2003), 24.