# ON THE VERY POSSIBILITY OF INTELLIGENT DESIGN

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**ABSTRACT:** *Is this world the kind of place where an intelligent designer—usually conceived as God—can become perfectly evident on rational and empirical grounds? Most secular thinkers say no. The received view is that knowledge about God is a matter of faith, and not a matter of rational or empirical inquiry. In particular, contingent facts about the world are viewed as ultimately irrelevant to religious truths. The purpose of this essay is to refute the received view. I shall argue that the world is the kind of place where supernatural design can become perfectly evident on rational and empirical grounds. To make my case I look not to miracles, but to the intractable problems of computer science. What makes my argument work is the existence of intractable computational problems for which finding a solution is beyond the computational resources of the universe, but for which checking a solution, once it is available, is easy.*

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## 1. Lessing's Legacy

Gotthold Ephraim Lessing is perhaps best remembered for the following celebrated remark: "Accidental truths of history can never become the proof of necessary truths of reason." In the history of ideas Lessing's remark is doubly significant for appearing in a work concerned with how rational beings like ourselves can be rationally justified in holding religious beliefs (*Über den Beweis des Geistes und der Kraft*, 1777). Lessing aimed his remark at the truths of theology, not at the necessary truths of mathematics. By stressing as he did that any religious affirmation based on historical events is a matter of faith and not reason, Lessing inserted a wedge between the eternal truths of revelation and the messy contingencies of history. The effect of Lessing's remark was therefore to decouple the events of history from the truths of revelation. The conception of history that ensued stood in contrast with that of Augustine, Thomas, or Bossuet, for whom history was always the medium by which revelation became concrete and knowable (the Incarnation of Christ serving as the primary example). Lessing therefore did much more than accept Leibniz's distinction between necessary truths of reason and contingent truths about the world; he also endorsed Spinoza's thesis in the *Tractatus Theologico-Politicus* that the truths of history, however well confirmed, are incapable of giving us definite knowledge about God.

Two hundred years later, after multiple revolutions in science and philosophy, with Lessing's name no longer a household word, Lessing's dictum still characterizes the secular response to any inference that begins with the messy contingencies of history and ends with a non-vacuous claim about God. Of course much of what has been called natural theology has depended on just such an inference. Paul's claim that God's "eternal power and divine nature, invisible though they are, have been understood and seen through the things he has made" [Romans 1:20] not only stands in clear opposition to Lessing's dictum, but has throughout Church history been seen as granting the imprimatur to natural theology.

The two pillars of Christian apologetics have traditionally been natural theology and historical evidences. Both have leaned heavily on contingent facts about the world to support

theological claims about the existence, nature, and purposes of God. Natural theology and evidential apologetics differ in scope and emphasis, not in the importance they attach to contingent facts. Natural theology inquires into what can be known about God through the study of nature and the exercise of reason. On this view nature becomes God's general revelation to humankind, and reason the tool for comprehending nature. Natural theology, if you will, harvests the general revelation for insights into the deity. Evidential apologetics, on the other hand, takes the special revelation of Scripture and ecclesiastical tradition, and tries to validate it through such disciplines as history, archaeology, anthropology, literary criticism, and philology.

It remains that both natural theology and evidential apologetics look to contingent facts about the world to settle questions about God. Against this Lessing and his modern day successors hold that both enterprises are ill-conceived. Lessing's denial that definite knowledge about God is possible through studying the world has become commonplace. Indeed, in secular circles Lessing's dictum has become axiomatic. Unfortunately, many Christian thinkers have conceded Lessing's point, if only to sidestep the relentless critique of secularism. Theological pessimism over the soundness of reason in the face of sin is one reason for this concession. Thus a thorough-going Calvinist might argue that Lessing's dictum is innocuous since a mind blinded by sin will hardly be amenable to the persuasion of reason. Pessimism about the power of both reason and empirical investigations to obtain insights about God is therefore consistent with at least a tacit acceptance of Lessing's dictum.

Theological diffidence also plays into the concession. Science in its imperialist mode seeks to provide a total account of the world in purely naturalistic categories. Since the supernatural is by definition beyond the reach of naturalistic categories, theologians with a stake in the supernatural often find themselves intimidated, forced to relegate their religious claims to second rate epistemological categories like the noumenal, the subjective, and the mystical. For a religion like Christianity, whose chief claim had always been that in Christ the divine had invaded the natural world, to admit Lessing's dictum is to surrender the empirical content of this claim. The unfortunate consequence of severing the Incarnation from its empirical content is

that it issues in a fideism which on the one hand holds little attraction to modern-day secularists, and on the other hand bears little resemblance to the faith of Augustine, the Cappadocian Fathers, Thomas, Wycliffe, Luther, Calvin, and Wesley, all of whom believed not just in the Incarnation, but in an actual bodily resurrection of Christ which among other things served to validate the Incarnation.

Theological pessimism and diffidence aside, the question remains whether Lessing's dictum is true. Lessing's dictum claims that "accidental truths of history can never become the proof of necessary truths of reason." What sort of claim is this? Lessing certainly had religious sympathies. He always retained some conception of God, even if it was Spinozist. Whatever Lessing thought of God, he certainly regarded God as having some influence over the accidental truths of history. Lessing was therefore not seeking an ontological distinction between the accidental truths of history and the necessary truths of reason. The key word in his dictum is "proof." Lessing's dictum is an epistemological claim. We can't *prove* eternal things from temporal things. Lessing claims a limitation on knowledge. Now whenever someone informs me that I can't know something, I find myself recalling the words of G. K. Chesterton: "We don't know enough about the unknown to know that it is unknowable."

Certainly if Lessing means that contingent facts cannot provide strict mathematico-deductive proofs of necessary truths, I would agree. But Lessing's claim is uninteresting if this is how he construes proof. Lessing's claim becomes interesting only if proof is broadly conceived. Is the world incapable of supplying convincing evidence for theological truths? It's worth remembering that in Lessing's day deism was the rage. For deists it was anathema that God should violate nature by sporadic interventions. Miracles were taboo. As Voltaire put it, "To suppose that God will work miracles is to insult Him with impunity." This sentiment was imported to our own continent by Ralph Waldo Emerson, who likewise felt God's dignity threatened by miracles: "To aim to convert a man by miracles is a profanation of the soul."[1] Suffice it to say, Lessing would not have admitted miracles as a counterexample to his dictum.

What then can serve as a counterexample to his dictum? What sort of necessary

theological truth can, at least in principle, be strongly supported by contingent facts about the world? The existence of a supernatural designer, I claim, fits the bill. I look for three things in a supernatural designer—intelligence, transcendence, and power. By power I mean that the designer can actually do things to influence the material world—perform miracles if desired. By transcendence I mean that the designer cannot be identified with any physical process, event, or entity—the latter can at best be attributed to the designer, not equated with the designer. By intelligence I mean that the designer is capable of performing actions which cannot adequately be explained by appealing to chance—the designer can act so as to render the chance hypothesis untenable. I shall argue that contingent facts are well equipped to provide compelling evidence for thinking that these three attributes are consistently united in one being.

## 2. The Kantian Question

Even if we are skeptical about miracles serving as a valid counterexample to Lessing's dictum, miracles are a good place to start looking for contingent facts that implicate noncontingent truths. The use of miracles to confirm faith goes back at least to the doubting Thomases of Scripture, and extends to the Woody Allens of today. Normally the connection is stated in terms of a challenge:

> If only God would give me some clear sign! Like making a large deposit in my name at a Swiss bank.[2]

In uttering this remark, Woody Allen issues a challenge (perhaps to God, perhaps to no one). Suppose for the moment that there is a God and that this God decides to take Allen seriously. Would an unexpected $7,000,000, say, in Allen's Swiss bank account rightly convince Allen that God is real? Suppose a thorough examination of the bank records fails to explain how the money appeared in Allen's account. Should Allen conclude that God has given him a sign?

Since I can't answer for Allen, let me answer for myself. If I were a famous personality having uttered Allen's remark, and subsequently found an additional $7,000,000 in my Swiss bank account, I would certainly not have attributed my unexpected good fortune to the largesse

of an eccentric deity. It's not that I don't believe in God—I do. But my theology constrains me to think it unworthy of God to grant flippant requests like Allen's and then apparently ignore the urgent requests of so many suffering people in the world.

I would refuse to acknowledge a miracle for theological reasons. Barring theological reasons, however, I would still refuse to acknowledge a miracle. Why? Well, other explanations readily come to mind. If I had uttered the remark and were as famous as Allen, and if $7,000,000 had appeared in my account, I would probably have concluded that some eccentric billionaire with a religious agenda was trying to convert me to his cause. The strange appearance of the $7,000,000 would have been fiendishly designed to make me believe in God. But alas, I was too clever for them!

There is a point to these musings. Allen's remark is clearly funny; however, if taken seriously it becomes self-defeating. If God were in fact to do what Allen requested, Allen and just about anyone else would remain unconvinced. But perhaps Allen's error was in asking for too picayune a sign from God. After all, if God is all he is cracked up to be (e.g., omniscient, omnipresent, omnipotent, infinite, perfect, ...), God can certainly do a lot more than deposit a paltry $7,000,000 in a Swiss bank account. Why not ask God to do something truly flamboyant? Norwood Russell Hanson, philosopher of science *extraordinaire* at Yale until his premature death, did just this when he described the conditions under which he would become a theist:

> I'm not a stubborn guy. I would be a theist under some conditions. I'm open-minded. . . . Okay. Okay. The conditions are these: Suppose, next Tuesday morning, just after breakfast, all of us in this one world are knocked to our knees by a percussive and ear-shattering thunderclap. Snow swirls, leaves drop from trees, the earth heaves and buckles, buildings topple and towers tumble. The sky is ablaze with an eerie silvery light, and just then, as all of the people of this world look up, the heavens open, and the clouds pull apart, revealing an unbelievably radiant and immense Zeus-like figure towering over us like a hundred Everests. He frowns darkly as lightning plays over the features of his Michelangeloid face, and then he points down, *at me*, and explains for

> every man, woman and child to hear: "I've had quite enough of your too-clever logic chopping and word-watching in matters of theology. Be assured Norwood Russell Hanson, that I do most certainly exist!"[3]

Would that do it? I suggest that a prodigy of the sort described might not elicit the faith Hanson seems to think mandatory. Flamboyance has its price. There is the theological price: no God of any respectable theology would engage in the sort of magic show that Hanson desires to see. But even if we leave theological scruples aside, there is the question about how best to explain the prodigy Hanson describes. Certainly there are other explanations besides the appeal to God. Hallucinations, dreams, smoke and mirrors, and simulated realities by means of holograms are just a few of the alternate explanations that spring to mind. Flamboyant miracles, precisely because they involve a large scale disruption of the normal course of events, instead to producing faith might actually work against faith by causing us to question such fundamental assumptions as whether we are accurately perceiving reality. For God to do things that are too bizarre might cause us to question our own sanity and therefore our capacity to assess whether God exists.

Finally, even if we don't question our sanity, it's not clear we get a supernatural designer in the full sense of the word. Certainly a being that could meet Hanson's challenge would be intelligent and powerful, but it's not at all clear that this being would be transcendent as well. Presumably it's possible for technologically advanced extraterrestrials to offer us a freak show which would cause us to take seriously their claims to godhood, much as we Westerners might be able to dazzle the aborigines of Borneo into believing that we are gods through the power of our technologies. Dazzle alone, however, won't buy you transcendence. A designer who is strictly outside the physical universe has to be more than a good entertainer.

The question therefore remains whether God in his capacity as a supernatural designer can do anything that would provide convincing proof that he had indeed acted. Let me put it this way: Is there anything that has, could, or might happen in the world from which it would be reasonable to conclude that a supernatural designer had acted? Are there or could there be any

facts in the world for which an appeal to a supernatural designer is the best explanation? Or to reverse the question, is supernatural design always an easy way out, a lame excuse, a prescientific device that invariably misses the best explanation?[4]

We are asking a transcendental question in the Kantian sense: What are the conditions for the possibility of knowing that an instance of supernatural design has occurred in the actual world? This question must be answered at the outset, for if this world is the type of place where anything even in principle that happens can be adequately explained apart from teleology and design, then Lessing was right. Might the world do something, however quirky, that would convince us of design?

An illustration may help. Imagine a peculiar art studio comprised of 10 inch by 10 inch canvasses, a full range of oil paints, and a robot which paints the canvasses with the paints. In painting the canvasses, the robot divides each canvas into a 10 by 10 grid of one inch squares, and paints each square with precisely one color. Imagine that this robot also has visual sensors and thus can paint scenes presented to its visual field, though only crudely given the coarse grained approach it adopts to painting. Imagine next that Elvis and an Elvis impersonator come to have their portraits painted by this robot. Will the portraits distinguish Elvis from his impersonator? Because the representations on canvas are so crude, if the impersonator is worth his salt, the two portraits will be indistinguishable. Our imaginary art studio cannot distinguish the real Elvis from the fake Elvis.

This example indicates what is at stake in determining whether design has at least the possibility of being detected and empirically grounded. Putative instances of design abound. But is it possible within this world to distinguish authentic from spurious design should instances of authentic design even exist? Or is this world like the preceding art studio—just as the portraits painted at the studio cannot distinguish the real from the fake Elvis, so too is it impossible for our empirical investigations of the world to distinguish authentic from spurious design?

Now Lessing's dictum implicates just this, namely that the world is the kind of place

where all objective phenomena, insofar as they can be explained rationally, must be explained without recourse to non-naturalistic factors. For to transcend naturalistic factors by invoking God is to say something about God, and thus to establish necessary truths from accidental truths. Non-naturalistic factors therefore have no place in rational explanation. George Gaylord Simpson puts it this way:

> There is neither need nor excuse for postulation of nonmaterial intervention in the origin of life, the rise of man, or any other part of the long history of the material cosmos.[5]

Simpson claims that the world is the kind of place where no objective, empirical finding can ever legitimately lead us to postulate design (what he calls "nonmaterial intervention").

This is a bold claim. The question remains whether it is true. In the case of the art studio, it is true that robot portraits of Elvis and his impersonator will fail to distinguish the two. The paintings produced by the studio are simply too coarse grained to do any better. From these paintings there is, to use Simpson's phrase, "neither need nor excuse for postulation of" two Elvises—the real and the fake. From the portraits alone we might legitimately infer only one sitter. But is the world so coarse grained that it cannot even in principle produce events that would evidence design? This is what both Simpson and Lessing seem to be affirming. A little reflection, however, indicates that this claim cannot be right.

## 3. Oracles

The method of science fiction has become popular within philosophy in recent years. Its analogue in the physical sciences is the thought experiment. What we do is imagine an event or circumstance, which though not in our power to produce, nevertheless might take place (perhaps only as an extremely improbable thermodynamic accident).[6] Thought experiments are supposed to stretch our thinking and give us fresh insights into well-worn areas of study. Since Lessing and his present-day counterparts like Simpson believe the actual world is incapable of producing events that clearly exhibit design, the task before us is to formulate a thought experiment which shows that the world does indeed possess this power. We are after a type of thought experiment

that implicates design. In contrast to the preceding art studio, I shall demonstrate that the world is sufficiently fine grained to produce events for which design is a compelling inference.

I'll start by considering a general class of thought experiments. These are the thought experiments from theoretical computer science known as *oracles*. Oracles are thought experiments that solve intractable problems, i.e., problems that currently cannot be solved by computational means. Intractable problems comprise those that can be programmed but require too long to run, and those that are incapable of being programmed at all (e.g., the problem of determining whether the decimal expansion of $\pi$ has a hundred consecutive 7's currently constitutes an intractable computational problem). On the other hand, problems that can be programmed and whose programs yield a solution after a reasonable amount of running time are known as tractable (e.g., sorting problems, as in alphabetizing lists, constitute tractable computational problems). Now computer scientists are not ready to give up on intractable problems. Intractable problems might after all become tractable if a program can be discovered that solves the problem without eating up too many computational resources. To keep their hands on the pulse of intractable problems, computer scientists therefore regularly employ oracles.

An oracle can be conceived as a black box which solves a certain problem or class of problems instantaneously, but for which the method of solution is a matter of ignorance. The reason for calling the box "black" is that we don't know what's going on inside—the box is opaque. We don't know, nor do we care, what's happening inside the box. All that's necessary is that the oracle reliably solve the problems it is supposed to solve. How it goes about it or even whether there is a practical way of going about it, we don't care.

Since oracles are thought experiments, oracles don't exist as programs running on real computers—if they did, the whole notion of an oracle would be redundant. Oracles are therefore purely conceptual devices. They solve problems, often subproblems of bigger problems, without specifying a method. In computer science divide-and-conquer is generally the strategy of choice. To solve a problem, break it into smaller problems, and then solve these subproblems

individually. Often the solution to a big problem can be reduced to a collection of smaller problems all of which but one is tractable. In this case it can be useful to supply an oracle that solves the one remaining intractable problem. With this oracle in hand, the original problem can now be solved. In this way the oracle for the subproblem illuminates the original problem. Conversely, any solution to the original problem illuminates the oracle.

For this discussion we shall focus on one particular type of oracle. This is the type of oracle that in solving problems beyond the capacity of human or computer problem solvers produces a solution which nevertheless is verifiable by human or computer problem solvers. Generally in mathematics and computer science we are confident that a problem has been solved when we have carried out some well-defined procedure that is guaranteed to lead to a solution. If no such procedure exists, we are unable by our own efforts to secure a solution. Nevertheless, it may be possible to check whether a proposed solution is correct, even if we have no idea how the proposed solution was discovered. Here then is where the oracle comes in. *Checking* a solution is typically easier than *generating* a solution. The oracle will solve our problems for us. We want, however, to be sure that the oracle has solved them correctly—we don't want the oracle misleading us. We therefore need a way of checking up on the oracle to make sure it is producing correct results.

A simple example might help. Suppose your education in arithmetic was abysmal—suppose all you learned was how to do addition. Subtraction, multiplication, and division are beyond you. You never figured them out and you have no way of doing them, even if your life depended on it. Suppose you are not alone. For some reason in the years you were educated a whole generation learned nothing about arithmetic except addition. The bank where you deposit your money recognizes this deficiency. Because it wants you to maintain an active checking account, it encourages you (and its other customers like you) to learn how to subtract so that you can keep your checkbook up to date. You resist this. Tired of encouraging remedial arithmetic for its customers, the bank issues to each of its customers an oracle that subtracts (e.g., a calculator). You are intrigued. Finally you can keep your checkbook up to date without having

to consult your children (whose course in arithmetic included subtraction, but not multiplication and division—alas).

Because, however, you are skeptical by nature, you wonder whether the bank gave you an oracle that subtracts accurately. The bank after all might have an interest in supplying you with a misleading oracle that indicates you have less in your account than you actually do (say by subtracting more than it should). The bank might then try to keep the difference. But now you learn from your daughter, who knows both addition and subtraction, that you can check up on the oracle by adding what was subtracted and the difference, and then seeing whether it equals your previous total. You know addition. You can therefore keep tabs on the oracle, even if you don't know how or why it tells you what it does. To your relief, you find that the oracle does indeed subtract correctly.[7]

Oracles which can be checked in this way are verifiable. *Verifiable oracles* provide solutions we can check to problems we cannot solve. In the sequel we shall limit ourselves to verifiable oracles. Verifiable oracles enable us to address the question that has been exercising us: Is there anything that might happen in the world which would convince us a designer has acted? Lessing refused to give design a place in rational inquiry. Simpson claimed there could never be a need to postulate "nonmaterial intervention." Together they answer this question with a resounding No. The following oracle, however, shows that the answer to this question must in fact be Yes.

## 4. The Incredible Talking Pulsar

Imagine that astronomers have discovered a pulsar some three billion light years from the earth. The pulsar is, say, a rotating neutron star that emits regular pulses of electromagnetic radiation in the radio frequency range. The astronomers who found the star are at first unimpressed by their discovery—another star to catalogue. One of the astronomers, however, is a ham radio operator. Looking over the pattern of pulses one day, he finds that they are in Morse code. Still more surprisingly, he finds that the pattern of pulses signal English messages in

Morse code.[8]

Word quickly spreads within the scientific community, and from there to the world at large. Radio observatories around the globe start monitoring the "talking" pulsar. The pulsar isn't just transmitting random English messages, but is instead intelligently communicating with the inhabitants of earth. In fact, once the pulsar has gained our attention, it identifies itself. The pulsar informs us that it is the mouthpiece of Yahweh, the God of both the Old and the New Testaments, the creator of the universe, the final judge of humankind.

Pretty heady stuff you say. But to confirm this otherwise extravagant claim, the pulsar agrees to answer any questions we might put to it. The pulsar specifies the following method of posing and answering questions. The descendants of Levi are to make an ark like the one originally constructed under Moses (see Exodus 25). This ark is to be placed on Mount Zion in Israel. Every hour on the hour a question written in English is to be placed inside the ark. Ten minutes later the pattern of pulses reaching earth from the pulsar will answer that question, the answer being framed as an English message in Morse code.[9]

The information transmitted through the pulsar proves to be nothing short of fantastic. Medical doctors learn how to cure AIDS, cancer, and a host of other diseases. Archaeologists learn where to dig for lost civilizations and how to make sense out of them. Physicists get their long sought after unification of the forces of nature. Meteorologists are forewarned of natural disasters and weather pattern years before they occur. Ecologists learn effective methods for cleansing and preserving the earth. Mathematicians obtain proofs to many long-standing open problems—in some cases proofs they can check, but proofs they could never have produced on their own. The list of credits could be continued, but let us stop here.

What shall we make of the pulsar? Whether the pulsar is in fact the mouthpiece of Yahweh, the pulsar creates serious difficulties for any naturalistic conception of the world. Not only is there no way to square the pulsar's behavior with our current scientific understanding of the world, but it is hard to conceive how any naturalistic explanation will ever account for the pulsar's behavior. For instance, our current scientific understanding based on Einsteinian special

relativity tells us that messages cannot be relayed at superluminal speeds, i.e., at speeds faster than the speed of light. Since the pulsar is three billion light years from the earth, any signal we receive from the pulsar was sent billions of years ago. Yet the pulsar is as it were "responding" to our questions within ten minutes of the written questions being placed inside the ark. The pulsar's answers therefore seem to precede our questions by billions of years.

To get around this physicists might wish to postulate reverse causality (i.e., causation in which the causes, instead of as is usual preceding their effects, actually come later than their effects) or superluminal signaling (i.e., signaling at speeds faster than the speed of light). This is perhaps more congenial than postulating "nonmaterial intervention," but reverse causality and superluminal signaling hardly begin to address the questions raised by the pulsar. It is inescapable that in dealing with the pulsar we are dealing with not just an intelligence, but a super-intelligence. Now by a super-intelligence I don't mean an intelligence that at this time surpasses human capability, but which in time humans can hope to attain. Nor do I mean a super-human intelligence which might nevertheless be realized in some finite rational material agent embedded in the world (say an extra-terrestrial intelligence or a conscious super-computer). By a super-intelligence I mean an intelligence which surpasses anything that physical processes are capable of offering. This is an intelligence which exceeds anything that humans or finite rational agents in the universe are capable of even in principle.

How can we see that the pulsar instantiates a super-intelligence? Theoretical computer science and the notion of a computational resource helps point the way. The functioning of any computer can be fully described by the switching of finitely many on-off devices, commonly known as bits. Just what physical form the bits take is unimportant (Babbage's original inference engine was purely mechanical; nowadays bits are instantiated electronically). What is important is that the bits allow exactly two states and reliably indicate which one of the two states currently obtains. Now it is intuitively obvious that according to this picture a computer becomes increasingly powerful as the number of bits as well as the speed with which the bits can be turned on and off increase. The number of available bits corresponds to the computer's

memory size, the maximal switching rate of the bits to the computer's clock speed. Together, memory size and clock speed determine the computer's computational resources.

Now there are problems in computer science which can be shown mathematically to require more computational resources for their solution than are available in the universe. Think of it this way: the universe can supply only so many bits for use in a computer; moreover, the laws of physics limit the speed with which any of these bits can be switched. Together these constraints limit how big and fast a computer can be, and thereby the range and complexity of the problems that can be solved on any computer. Any computer built out of the physical stuff of the universe will be limited by these constraints.

We can put some numbers to these constraints. There are estimated to be no more than $10^{80}$ elementary particles in the universe. The properties of matter are such that bits, whatever form they take, cannot be switched faster than $10^{45}$ times per second.[10] The universe itself is about a billion times younger than $10^{25}$ seconds (assuming the universe is around ten billion years old). Given these upper bounds no computation exceeding

$$10^{80} \times 10^{45} \times 10^{25} = 10^{150}$$

elementary steps is possible within the universe, where by an elementary step I mean the switching of an on-off device, conceived abstractly as the switching of a binary integer (= bit). Note that the units of this equation are as follows: $10^{80}$ is a pure number—an upper bound on the number of elementary particles in the universe; $10^{45}$ is in hertz—oscillations or bit-switches per second; $10^{25}$ is in seconds—an upper bound on the number seconds that the universe endures; finally $10^{150}$ is in oscillations or bit-switches—the total number of bit-switches throughout the course of the universe. For a computation of this complexity (i.e., $10^{150}$ bit-switches) therefore to be carried out in the universe, every available elementary particle in the universe would have to serve as an elementary storage device (= memory bit) capable of switching at $10^{45}$ hertz over a period of a billion billion years.

$10^{150}$ is incredibly generous as an upper bound on the complexity of computations possible in the universe. Here are a few reasons why a much smaller bound will do: (1)

quantum mechanical considerations indicate that reliable memory storage is unworkable below the atomic level[11] since at this level quantum indeterminacy will make not only storage, but also reading and writing of information impossible. Hence each elementary storage device will have to consist of more than one elementary particle. (2) The preceding calculation treats the universe as a giant piece of random access memory (RAM) that is controlled by a processor outside the universe operating at $10^{45}$ hertz with instant access to any memory location in RAM. In fact, the processor will itself have to take up part of the universe. Moreover, its access to memory locations will have in most cases to be measured in light years and not in $10^{-45}$ second chunks. Even with massively parallel processing, computation speeds will fall far below the $10^{45}$ hertz upper bound. (3) Finally, the bound of $10^{25}$ seconds for the maximum running time of a computation is excessive since either the heat death or the collapse of the universe will probably have occurred by then. Suffice it to say, even with the entire universe functioning as a computer, no computation requiring $10^{150}$ elementary steps, much less $10^{150}$ floating point operations, is feasible.[12]

Now it is possible to pose problems in computer science for which the quickest solution requires well beyond this number of steps, yet for which with a solution in hand it is possible even for humans using ordinary electronic computers to check whether the solution is correct. Factoring integers into primes is thought to be one such problem. Since the factorization problem is easy to understand, let me treat it as though it were one of the "provably hard problems." If at some time in the future a "quick" algorithm is found for factoring numbers, we shall need to modify this example; nevertheless, our contention that there are problems whose solution is beyond the computational resources of the universe, yet verifiable by humans will still hold.[13]

What is the factorization into primes of 1961? Solving this requires a bit of work. But if you are given the prime numbers 37 and 53, it is a simple matter to check whether these are prime factors of 1961. In fact 37 x 53 = 1961. Factoring is hard, multiplication is easy. We can therefore go to our pulsar with numbers thousands of digits long and ask it to factor them.

Factoring numbers that long is totally beyond our present capabilities and in all likelihood exceeds the computational limits inherent in the universe by many, many orders of magnitude (when I was following the literature on factoring a few years back, numbers beyond two hundred digits in length could not be factored unless they had either small or special prime factors). Nevertheless, it is easy enough to check whether the pulsar is getting the factorizations right, even for numbers thousands of digits in length.

The pulsar is a super-intelligent verifiable oracle. As a verifiable oracle the pulsar extends our knowledge of the world by enabling us to verify its claims. I indicated that science, history, and even the future all fall within the pulsar's competence. Such knowledge is beyond human capabilities and therefore guarantees that the pulsar's knowledge is super-human. But in such matters of contingent fact we might still wonder whether the pulsar's intelligence is similar to our own, only much more sophisticated. Such an intelligence might still derive from some physical system and be tied fundamentally into the material universe. The pulsar's solution of intractable computational problems, however, makes it tough to avoid postulating "nonmaterial intervention." Indeed, the resources simply aren't there in the material universe to account for the pulsar's solution to intractable computational problems. Let me put it this way: if you've solved a problem and the resources for solving the problem weren't available in U, then you had to go outside U to solve the problem. In this case U is the universe. The solution by the pulsar of intractable computational problems guarantees that the super-intelligence communicating through the pulsar is in fact a supernatural intelligence.

## 5. Lessons from the Pulsar

What lessons can we learn from the pulsar? First we should infer that a designer in the full sense of the word is communicating through the pulsar—a designer who is both intelligent and transcendent. Intelligence is certainly not a problem here. Alan Turing's [1950] famous test for intelligence pitted computer against human in a contest where a human judge was to decide which was the computer and which was the human. If the human judge could not distinguish the

computer from the human, Turing wanted intelligence attributed to the computer. This operationalist approach to intelligence has since been questioned, by theists on one end and hard-core physicalists on the other. But the basic idea that there is no better test for intelligence than coherent natural language communication remains intact. If we can't legitimately attribute intelligence to the pulsar, then no attribution of intelligence should count as legitimate. Transcendence is clear as well given our discussion of intractable computational problems. Suffice it to say, a being that solves problems beyond the computational resources of the material world is not material. When we can confirm that such problems have in fact been solved for us, we cannot avoid postulating "nonmaterial intervention."

Second we should consider any appeal to chance in explaining the pulsar's behavior as unacceptable. Confronted with our pulsar, the inveterate naturalist might want to adopt the following line: Pulsars emit electromagnetic radiation in pulses, but the precise causal factors for spacing the pulses are beyond our knowledge. Over an extended period of time the number of sequences of pulses that the pulsar might emit is huge. Of these the number of coherent English messages in Morse code is still huge, but minute when compared to the total number of possible sequences. Hence it is possible that in observing the pulsar we are merely witnessing an extremely unlikely chance event. The chance process responsible for the event appears to be communicating with us intelligently through the pulsar, but in fact it isn't. Randomness and chance alone are at work. Perhaps there are other pulsars out there also emitting coherent English messages by chance. Naturalists might even want to refer to such pulsars as "informational singularities." Most worlds obeying our physical laws don't contain informational singularities. Ours, however, might just be one of those worlds that contains an informational singularity. The inveterate naturalist is urging a chance hypothesis. Not only does this appeal to chance violate every conceivable canon of statistical reasoning, but it is also highly implausible. In the event of such a talking pulsar, a much more plausible hypothesis would be that the works of Shakespeare were the product of chance (cf. Thomas Huxley's simian typists[14]).

Third, we should note that many of the physical details in the pulsar example could be changed without affecting our general conclusions. I chose the pulsar because it is startling. It clashes with special relativity and turns naturalism on its head. Nevertheless, any physical system whose dynamics are unpredictable could provide convincing evidence of design. Consider for instance a chunk of uranium undergoing radioactive decay. Suppose that whenever a uranium atom from the chunk decays, we treat it as a pulse. Suppose moreover that the sequence of pulses so derived from the chunk of uranium can be interpreted as English messages in Morse code. The chunk of uranium becomes in this way an oracle that communicates with us much as the pulsar. Indeed, the content of its messages can be identical with that of the pulsar. Note that if the chunk of uranium is made available to public scrutiny, its empirical support becomes as secure as that of the pulsar.

Fourth, the possibility of a super-intelligent verifiable oracle is independent of whatever our current scientific understanding of the world happens to be. Science always operates against a backdrop of regularities. Although these regularities restrict what is physically possible, they cannot restrict the messages that physical systems operating within those regularities are capable of transmitting. Take for instance the physical system that comprises me. I claim that I am able to transmit any conceivable English message in Morse code. Suppose a neuroscientist wants to dispute this claim. To succeed he must produce a counterexample, i.e., a message in Morse code that I am unable to produce, say because my nervous system is constituted in a particular way. But this is absurd, for I can certainly copy the message if it is presented to me. And what is to prevent my getting the message and copying it? Perhaps now the neuroscientist wants to team up with a physicist, with the neuroscientist claiming that I shall never be able to reproduce a certain message if it is not presented to me, and the physicist guaranteeing that the message shall indeed never be presented to me (presumably because the constitution and dynamics of the physical world precludes this message from getting through to me). Let's say the neuroscientist is right. How can the physicist validate his claim? Can he guarantee that nobody will steal the message and get it into my hands? Can he guarantee that no pulsar will transmit the message to

me? Can he guarantee that when I look at the random behavior of a quantum mechanical system that I won't to my surprise find the message transmitted to me? Physics has no way of barring the message from me and hence has no way of preventing me from copying the message once it is in my possession. A fortiori it has no way of limiting the messages that the physical system named Bill Dembski is capable of transmitting—save one: if the message is too long, I might expire before transmitting the whole message.

The fifth and final lesson I want to draw is this: Access to a super-intelligent verifiable oracle may be limited and yet totally convincing to those who have access. The pulsar was an example of an oracle accessible to the inhabitants of earth generally. Indeed, observatories around the globe can monitor and record its transmissions. Access to an oracle can, however, be restricted. Suppose for instance I have a "magic penny." Whenever I flip the penny twice I treat two tails in a row as a dot, two heads in a row as a dash, a tail followed by a head as a letter space, and a head followed by a tail as a word space. Whenever I flip the coin an even number of times I now interpret the sequence of coin flips as a message in Morse code. What makes my penny "magic" is that it communicates to me English messages in Morse code. Suppose the penny communicates profound and marvelous things about the world, much as the pulsar. Suppose, however, that I refuse to inform anyone about my magic penny. I personally will be convinced that a designer is communicating with me through the penny, even though I may never care to convince anyone else of this fact. If I care to share my magic penny with a group of friends, then they will become believers in the penny. Yet the public at large will remain unconvinced.[15] Suffice it to say that individuals with access to a super-intelligent verifiable oracle have completely convincing evidence for design even if they are unable to convince those without the access.

## 6. The Evidence for Design

The pulsar shows that ours is the type of world where design has at least the possibility of becoming perfectly evident—with the pulsar empirical validation for design can be made as

good as we like. Design is therefore knowable on rational and empirical grounds. I've belabored this point because it is precisely this point that Lessing and his modern day disciples would rather not grant. Once, however, it is granted that the occurrence of certain events would constrain us to postulate design, the question arises whether any such events have actually occurred. Now it is obvious that the pulsar is an exercise in overkill. No instance of design so resoundingly obvious is known. A follow-up question therefore arises as well: How much more subtle can the evidence for design be, and yet clearly implicate design? This in turn leads to still another question: Why isn't the evidence for design as resoundingly obvious as it might be? Let me list and number these questions as follows:

(Q1) Have any events that would constrain us to postulate design actually occurred, and if so what are they?

(Q2) How subtle can the evidence for design be, and still constrain us to postulate design? In particular, what methods of inquiry would enable us reliably to detect these more subtle instances of design?

(Q3) Why isn't the evidence for design as obvious as it might be?

Since this essay is an inquiry into the possibility of design, rather than into the actual evidence for design, or even the precise methodology for detecting design, I am not strictly speaking obligated to answer these questions. After all, I've answered the question I set out to answer, namely, whether the world we inhabit is the kind of place where a designer can become perfectly evident. As we've seen, the answer to this question is a definite Yes. Nevertheless, I have a serious interest in these other questions as well. Indeed, I've addressed (Q1) and (Q2) elsewhere [Dembski 1991] and am currently co-authoring a book on the topic.[16] What's more, in the book you are reading Moreland and Meyer respond to (Q2), whereas Ross, Bradley, and Thaxton respond to (Q1). Yet because I am a practical man, who regards design as a topic worth discussing only insofar as design can make a genuine difference in how we live and view the world, I'll take up these three question here, though briefly.

Bertrand Russell, philosopher, mathematician, and author of among other works *Why I*

*am not a Christian*, was once asked how he would respond if upon dying he found himself in the presence of God and was asked why he hadn't believed in the existence God during his stay on earth. Russell's response was summed up in three words: *Not enough evidence!* Now I submit that most persons on hearing of Russell's response would conclude that in Russell we have a careful thinker who won't let himself be swayed by bogus or equivocal evidence. In other words, most people nowadays would regard Russell's skepticism as sober and measured. Atheism is regarded as a reasonable position these days because God, if he exists, has been too lazy or secretive to furnish us with convincing proofs of his existence.

Now it's worth noting that this attitude is of recent vintage. In other epochs atheism has been considered perverse and unreasonable. Thus the apostle Paul could write, "What can be known about God is plain to them, because God has shown it to them. Ever since the creation of the world his eternal power and divine nature, invisible though they are, have been understood and seen through the things he has made. So they are without excuse" [Romans 1:19-20]. Well then, what has God done to make his existence plain? If we look to nature, two things have stood out historically: the cosmos and living systems. The cosmos and living systems have historically been thought to provide excellent reasons for postulating design. Here then is the short answer to (Q1). Since in their essays Hugh Ross, Walter Bradley, and Charles Thaxton will take up the cosmos and living systems, showing how our scientific understanding of them, far from undermining design, makes design all the more compelling, I shall leave (Q1) aside and turn to (Q2), which is where the real philosophical difficulties lie.

With respect to the cosmos and living systems, (Q2) might be formulated as follows: if the cosmos and living systems provide such compelling evidence for design, why aren't more people convinced? I suggest that the problem lies not with the evidence per se, but with the methods of inquiry that are adopted to interpret the evidence. These methods decide whether design is even a legitimate area for inquiry in the first place. Indeed, there are methods of inquiry that do not permit design to get off the ground. The chief antagonist here is of course methodological naturalism, which excludes design from rational discourse on a priori grounds.

Although methodological naturalism was the topic of the previous essay by J. P. Moreland, I have a few thoughts to add to the matter.

The received view within scientific and academic circles generally is that science is on safest ground when it remains committed to naturalistic explanation. To invoke a designer is seen as a serious compromise, not only of scientific endeavor generally, but of scientific integrity. The worry is always that by invoking the supernatural, we give in to ignorance and superstition. A well known Sidney Harris cartoon makes the point as well as I know. Two scientists are standing at a blackboard. A course of calculations is interrupted by the phrase "then a miracle occurs." In the caption one of the scientists asks the other whether he might not be more explicit on this last point.

Although political correctness is a fairly recent development, scientific correctness has been with us for some time. C. A. Coulson [1955: 2] summarizes the key tenet of scientific correctness as follows:

> When we come to the scientifically unknown, our correct policy is not to rejoice because we have found God; it is to become better scientists.

Ian Barbour [1966: 390] adds,

> We would submit that it is scientifically stultifying to say of any puzzling phenomenon that it is "incapable of scientific explanation," for such an attitude would undercut the motivation for inquiry. And such an approach is also *theologically dubious*, for it leads to another form of the "God of the gaps," the *deus ex machina* introduced to cover ignorance of what may later be shown to have natural causes.

There is something heroic in the sentiments expressed by Coulson and Barbour. Given a difficult problem, the proper attitude is not to capitulate and admit irremediable ignorance, but rather to press on and struggle for a solution. What's more, even if no solution exists, we are to follow the example of Sisyphus, forever trying to roll the rock up the hill, ever striving to obtain a naturalistic solution, rather than lapsing into the easy comforts of a Sybarite and gratuitously invoking divine agency. Better to attempt the impossible than take the easy way out. Above all

we are ever to be mindful of C. S. Peirce's celebrated dictum, *Do not block the way of inquiry*. Among naturalists any appeal to God or the supernatural represents not just a violation of this dictum, but a descent into rank superstition.

While the sentiments that drive this commitment to naturalistic explanation are no doubt heroic, even Promethean, I submit that they are also misguided and derive from a fundamental confusion. Methodological naturalism confuses appeals to God that mask our ignorance of natural causes with appeals to God that arise because we have exhausted the full range of possible natural causes. To see what is at stake let me quote the last line of astronomer Edwin Hubble's *The Realm of the Nebulae*: "Not until the empirical resources are exhausted need we pass on to the dreamy realms of speculation." When Hubble wrote this line in the 1930's, he clearly believed that our empirical resources would not be exhausted and that our entrance into the dreamy realms of speculation could be postponed indefinitely. Indeed, Hubble did not intend his statement as a concession to dreamy speculators like myself. Nevertheless, Hubble's statement is a concession. What's more, it is a non-vacuous concession because empirical resources come in limited supplies and do get exhausted. Moreover, as soon as empirical resources are exhausted, naturalistic explanation loses its monopoly as the only legitimate explanatory strategy for science.

We've already seen how this worked for the pulsar—the pulsar exhausted our computational resources (= a type of empirical resource), and therefore required that we posit a non-material intelligence. What about living systems? Now while I don't deny that some speciation occurs in the manner described by Darwin, when it comes the origin of life there is a compelling argument to be made for design. Indeed, there are features of living systems that exhaust Hubble's empirical resources in the same way that a pulsar which solves intractable computational problems exhausts our computational resources. Such a revived design argument begins with living systems; looks to results from probability and information theory, cybernetics, computational complexity theory, molecular biology, and chemistry; and concludes that any naturalistic alternative to design fails. Since this argument will require an entire book to develop

(a book in whose writing I am currently engaged), I won't expand on it further.

Methodological naturalism suffers yet another drawback. Not only does it confuse appeals to God that result from our ignorance of natural causes with appeals to God that result from our knowledge of the essential limitations to natural causes, but it also perpetuates a prejudice, whose effect, far from facilitating inquiry, positively hinders it. The prejudice is this, that naturalistic explanation is somehow intrinsically better than non-naturalistic explanation. This is certainly a value judgment. I call it a prejudice because its effect on inquiry is limiting and destructive. Scientific inquiry, and inquiry in general, strives as far as possible to remove ignorance about how the world is and works. On this point I shall assume there is no controversy.[17]

Now suppose for the moment that God is an efficient cause in the material world, and that this God has assembled certain articles of matter with complete precision and control at the level of elementary particles. Then if the complexity and organization of such articles is sufficiently high, it may be possible to distinguish them reliably from articles produced through the regularities of nature, the effects of chance notwithstanding. But in this case any naturalistic explanation of such God-assembled articles will simply be false since naturalistic explanation will in this case attribute the wrong cause—natural lawlike processes rather than God. If ours is a world where God exists and actually does things, naturalism, by on a priori grounds blocking explanations that appeal to God, will actually block the way of inquiry—contrary to Peirce's dictum. Naturalism artificially limits our options. If ours is a world where God exists and actually does things that he intends us to know about, then naturalism prevents us from obtaining such knowledge. Methodological naturalism is therefore itself, to use Ian Barbour's phrase, "scientifically stultifying."

Finally, let me say a few words about the last question, (Q3). I call it the perspicuity question. Why isn't design more obvious? In the hands of an unsympathetic interlocutor this question is intended to point up how inherently disreputable the notion of design really is. Implicit in this question is the view that if a designer existed, this designer would spare no pains

making himself evident (e.g., by giving us a pulsar). Since obviously he has not made himself perfectly evident, he must not exist, or his existence need not concern us. In this form the argument against design parallels a standard version of the argument against God from evil. The argument from evil poses the following dilemma: If God is able but not willing to prevent evil, he is wicked. If God is willing but not able to prevent evil, he is impotent. Whence evil? In the case of design this dilemma can be recast as follows: If a designer is able but not willing to make himself perfectly evident, he is obscurantist. If he is willing but not able to make himself perfectly evident, he is inconsequential. What need therefore to postulate a designer?[18]

I believe it is this dilemma, often unspoken, which has been chiefly responsible for the demise of design arguments. This world is the type of place where design can become perfectly evident by any canons of scientific rigor. Moreover, instances of design more subtle than the pulsar exist and continue to convince many. The dilemma therefore has the effect of removing all subtlety from design: Unless the designer hits us with a sledgehammer, we shall remain unconvinced! No hints, no suggestions, no indications are judged sufficient to implicate design. This attitude is I suggest both obtuse and unscientific. Historically, science has judged the world a subtle place which our rationality succeeds in understanding only through toil and creative insight. Scientific discovery is not a matter of going to a cosmic supermarket where all the goods stare us in the face and everything is obvious from the labels. Scientific discovery is the work of a detective who with limited information reconstructs how the world is (if you're a realist about science), or formulates an empirically adequate account of how the world behaves (if you're an anti-realist about science).

How evident must design be to be plausible? How subtle can it be and remain plausible? I believe the proper course is not to prejudge these questions, but rather to consider what evidence there is for design and how best to make sense of it. I find it disingenuous for anyone to assume that if a designer has attempted to reveal himself in the natural order, this revelation must be not only obvious, but also ostentatious—not only is God supposed to sign each of his artifacts much as a painter signs a finished canvas, but God is supposed to use neon lights. Since

the designer has avoided ostentatious displays, one is supposed to conclude that no designer is revealed in the natural order. It is a fact, however, that human reasoning and problem solving must regularly transcend the obvious.

Inferring design is an activity humans engage in all the time. People find it important to distinguish purposeful, premeditated actions from chance events. Was a hit and run accident really an accident or was it a calculated assassination? Anyone who has sampled the suspense-action genre that clutters the cinemas understands the difference. The distinction between design and accident is not just widely recognized—whole industries are as it were dedicated to demarcating the distinction. These industries include patent offices, copyright offices, insurance companies, statisticians, cryptographers, and detectives to name a few. Now these industries typically refer design to human agents. But as we saw with the pulsar, circumstances might just as well constrain us to refer design to an intelligent agent strictly outside the physical world.

I conclude this essay with an observation due to Pascal. In the *Pensées* (no. 194) Pascal offers an insight which from the perspective of Christian theology is indispensable for understanding the difficulties that come with design:

> If the Christian faith boasted having a perfectly clear and unveiled view of God, to claim that nothing in the world demonstrates its truth with clarity would constitute an attack on the faith. But since, on the contrary, the Christian faith affirms that men are in darkness and estranged from God, that God does in fact give himself the name of *Deus absconditus* [Is. 45:15], . . . those who charge that nothing reveals the truth of Christianity in fact reveal how negligent they are in searching for the truth.[19]

Pascal describes the search for religious truth as neither straightforward nor futile. It isn't straightforward because "men are in darkness and estranged from God." It isn't futile because negligence is the primary obstacle to obtaining the truth.

Christian theology has long held that design is one of the ways God reveals himself to the world. Yet according to Pascal it is precisely because design is a way God reveals himself to the world that design will not be obvious. Design isn't transparently obvious because "men are in

darkness and estranged from God." To say this, however, is not to give theology an easy way out. Lessing offered theology an easy way out with his celebrated dictum. Lessing regarded reason as powerless to demonstrate religious truth. Pascal on the other hand affirmed no such thing. For Pascal, the problem was not with reason but with neglect and willful blindness. I urge Christians to ponder this point and ask themselves whether in relegating design to the garbage heap of passé theologies, as so many have done, they have not rather closed off an avenue by which people might otherwise come to know God.

## Notes

[1]The quotes from Voltaire and Emerson can be found in Jaki [1989: 39 and footnote 36]. Compare their quotes with Jesus' comment in John 14:11: "Believe me that I am in the Father and the Father is in me; but if you do not, then believe me because of the works themselves."

[2]Quoted in *Peter's Quotations*, s.v. "Doubt."

[3]Quoted from Gordon [1992: 7–8]. Hanson's challenge calls to mind Cleanthes' comment in David Hume's *Dialogues Concerning Natural Religion* [Hume 1779: 37]:

> Suppose, therefore, that an articulate voice were heard in the clouds, much louder and more melodious than any which human art could ever reach: Suppose, that this voice were extended in the same instant over all nations, and spoke to each nation in its own language and dialect: Suppose, that the words delivered not only contain a just sense and meaning, but convey some instruction altogether worthy of a benevolent Being, superior to mankind: Could you possibly hesitate a moment concerning the cause of this voice? and must you not instantly ascribe it to some design or purpose?

[4]Richard Dawkins certainly thinks so. Consider his comment on the origin of the DNA/protein machine: "[To invoke] a supernatural Designer is to explain precisely nothing, for it leaves unexplained the origin of the Designer. You have to say something like 'God was always there', and if you allow yourself that kind of lazy way out, you might as well just say 'DNA was always there', or 'Life was always there', and be done with it." [Dawkins 1987: 141]

[5]Quoted in Johnson [1991: 114].

[6]The Einstein-Podolsky-Rosen paradox for quantum mechanics derives from just such a thought experiment. Sometimes, as in this case, breakthroughs in technology enable the thought experiment to be carried out eventually—cf. the research of Alain Aspect [1982] and its important role in resolving the EPR paradox. In other instances the physical constraints on technology forever bar the thought experiment from becoming an actual experiment.

[7]This example may seem silly, but it captures precisely what is at stake with oracles. There are plenty of serious mathematical examples involving oracles, but to discuss them here I fear losing the reader in technicalities which are not central to this study. For a formal development of oracles, and in particular oracle Turing machines see Balcázar et al. [1988: 28–32].

[8]I owe the idea of a talking pulsar to Charles Chastain. The pulsar is an oracle. Here I am using oracles to investigate the possibility of design. Oracles, however, illuminate a host of philosophical questions. I have, for instance, used oracles to investigate the mind-body problem—see Dembski [1990: 203–205].

[9]Perhaps to make this story more convincing both the questions and the answers should be in Hebrew. I'm not sure, however, what Hebrew looks like in Morse code, so I'll stick with English.

[10]This universal bound on computational speed is based on the Planck time—currently the smallest physically meaningful unit of time. See Halliday & Resnick [1988: 544]. Universal time bounds for electronic computers involve clock speeds between ten and twenty magnitudes slower. See Wegener [1987: 2].

[11]Even at the atomic level quantum effects make reliable storage unworkable. Indeed, the smallest scale at which vast, reliable storage is known to be possible is at the next level up—the molecular level. We can thank molecular biologists for this insight.

[12]Throughout this discussion I have assumed a non-inflationary big-bang cosmology. Note, however, that inflation doesn't alter the numbers I've just presented. In an inflationary universe, what we normally regard as the universe (i.e., the sum total of energy that can potentially interact with us causally) is just one of a multitude of causally isolated subuniverses. The totality of these causally isolated subuniverses, if we are to believe Alan Guth and his disciples, contains more than $10^{80}$ elementary particles [see Guth & Steinhardt: 1989]. But those particles in subuniverses causally isolated from us cannot contribute to any computation in the subuniverse we inhabit. As a result, those particles in subuniverses causally isolated from us cannot serve as a computational resource within the subuniverse we inhabit.

[13]See Balcázar [1990: chapter 11] for the underlying theory. A simple example of a computational problem that is beyond the computational resources of the universe, yet verifiable by humans is the following: imagine a string of 0's and 1's of length a thousand is constructed by flipping a coin. This sequence is encoded on an integrated circuit, which in turn is connected to a computer. A programmer who has no knowledge of which string was encoded on the circuit must now determine the precise string. Unfortunately for him, the only way he can determine the string is by sending a test string to the circuit. If the test string matches the string encoded on the circuit, the circuit responds

Yes; otherwise No. How many test strings are there? $2^{1000}$, or approximately $10^{300}$, test strings exist. The programmer will therefore have to run through about $1/2 \times 10^{300}$ test strings before having an even chance of finding the string encoded on the circuit. Thus no matter how many copies of the circuit and now many computers the programmer has at his disposal (thereby enabling him to check multiple test strings at once), there are not enough computers and circuits that can be packed into the universe to give the programmer a hope of finding a solution. Of course, if the programmer is given the actual string encoded on the circuit, he can just send it to the circuit and immediately verify that he has the correct string. This example lacks aesthetic appeal, but makes the point.

[14]Huxley claimed that a huge number of monkeys typing away on typewriters would eventually type the works of Shakespeare [see Wilder-Smith 1975: 63]. If one assumes the monkeys are typing randomly, not favoring any keys, and not letting one key stroke influence another, Huxley's claim is a simple consequence of a fundamental theorem in probability known as the Strong Law of Large Numbers. Huxley's claim is in principle correct, but in practice carries no weight: the universe has neither enough monkeys nor enough time to make the typing of even the first line of *Hamlet*, much less the complete works of Shakespeare likely.

[15]Herein lies the problem with making parapsychology into a genuine science. Phenomena like extrasensory perception (ESP) or psychokinesis (PK), because they do not occur on demand, are convincing only to subjects and experimenters taking part in a successful parapsychological experiment.

[16]My co-authors are Steve Meyer and Paul Nelson.

[17]Epistemological relativists, social constructivists, and people who take a dim view of human rationality and its capacity to know truth will no doubt differ even on this point. They might care to have a look at Harris [1992] as well as Gilson [1990].

[18]It is worth noting that Christian theology has never required a perfectly perspicuous revelation. A case in point is the parables of Jesus. It is widely held that Jesus employed parables to clarify his message to the common folk. Yet when asked by his disciples why he spoke in parables, Jesus responded: "To you it has been given to know the secrets of the kingdom of heaven, but to them [the common folk] it has not been given. . . . The reason I speak to them in parables is that 'seeing they do not perceive and hearing they do not listen nor do they understand.'" [Matthew 13:11–13] Christian belief in God is not based on God blocking every avenue of doubt, but rather on God doing enough—both in our hearts and in the world—to elicit faith.

[19]The translation here is actually my own paraphrase.

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[7]This example may seem silly, but it captures precisely what is at stake with oracles. There are plenty of serious mathematical examples involving oracles, but to discuss them here I fear losing the reader in technicalities which are not central to this study. For a formal development of oracles, and in particular oracle Turing machines see Balcázar et al. [1988: 28–32].

[8]I owe the idea of a talking pulsar to Charles Chastain. The pulsar is an oracle. Here I am using oracles to investigate the possibility of design. Oracles, however, illuminate a host of philosophical questions. I have, for instance, used oracles to investigate the mind-body problem—see Dembski [1990: 203–205].

[9]Perhaps to make this story more convincing both the questions and the answers should be in Hebrew. I'm not sure, however, what Hebrew looks like in Morse code, so I'll stick with English.

[10]This universal bound on computational speed is based on the Planck time—currently the smallest physically meaningful unit of time. See Halliday & Resnick [1988: 544]. Universal time bounds for electronic computers involve clock speeds between ten and twenty magnitudes slower. See Wegener [1987: 2].

[11]Even at the atomic level quantum effects make reliable storage unworkable. Indeed, the smallest scale at which vast, reliable storage is known to be possible is at the next level up—the molecular level. We can thank molecular biologists for this insight.

[12]Throughout this discussion I have assumed a non-inflationary big-bang cosmology. Note, however, that inflation doesn't alter the numbers I've just presented. In an inflationary universe, what we normally regard as the universe (i.e., the sum total of energy that can potentially interact with us causally) is just one of a multitude of causally isolated subuniverses. The totality of these causally isolated subuniverses, if we are to believe Alan Guth and his disciples, contains more than $10^{80}$ elementary particles [see Guth & Steinhardt: 1989]. But those particles in subuniverses causally isolated from us cannot contribute to any computation in the subuniverse we inhabit. As a result, those particles in subuniverses causally isolated from us cannot serve as a computational resource within the subuniverse we inhabit.

[13]See Balcázar [1990: chapter 11] for the underlying theory. A simple example of a computational problem that is beyond the computational resources of the universe, yet verifiable by humans is the following: imagine a string of 0's and 1's of length a thousand is constructed by flipping a coin. This sequence is encoded on an integrated circuit, which in turn is connected to a computer. A programmer who has no knowledge of which string was encoded on the circuit must now determine the precise string. Unfortunately for him, the only way he can determine the string is by sending a test string to the circuit. If the test string matches the string encoded on the circuit, the circuit responds Yes; otherwise No. How many test strings are there? $2^{1000}$, or approximately $10^{300}$, test strings exist. The

programmer will therefore have to run through about $1/2 \times 10^{300}$ test strings before having an even chance of finding the string encoded on the circuit. Thus no matter how many copies of the circuit and now many computers the programmer has at his disposal (thereby enabling him to check multiple test strings at once), there are not enough computers and circuits that can be packed into the universe to give the programmer a hope of finding a solution. Of course, if the programmer is given the actual string encoded on the circuit, he can just send it to the circuit and immediately verify that he has the correct string. This example lacks aesthetic appeal, but makes the point.

[14]Huxley claimed that a huge number of monkeys typing away on typewriters would eventually type the works of Shakespeare [see Wilder-Smith 1975: 63]. If one assumes the monkeys are typing randomly, not favoring any keys, and not letting one key stroke influence another, Huxley's claim is a simple consequence of a fundamental theorem in probability known as the Strong Law of Large Numbers. Huxley's claim is in principle correct, but in practice carries no weight: the universe has neither enough monkeys nor enough time to make the typing of even the first line of *Hamlet*, much less the complete works of Shakespeare likely.

[15]Herein lies the problem with making parapsychology into a genuine science. Phenomena like extrasensory perception (ESP) or psychokinesis (PK), because they do not occur on demand, are convincing only to subjects and experimenters taking part in a successful parapsychological experiment.

[16]My co-authors are Steve Meyer and Paul Nelson.

[17]Epistemological relativists, social constructivists, and people who take a dim view of human rationality and its capacity to know truth will no doubt differ even on this point. They might care to have a look at Harris [1992] as well as Gilson [1990].

[18]It is worth noting that Christian theology has never required a perfectly perspicuous revelation. A case in point is the parables of Jesus. It is widely held that Jesus employed parables to clarify his message to the common folk. Yet when asked by his disciples why he spoke in parables, Jesus responded: "To you it has been given to know the secrets of the kingdom of heaven, but to them [the common folk] it has not been given. . . . The reason I speak to them in parables is that 'seeing they do not perceive and hearing they do not listen nor do they understand.'" [Matthew 13:11–13] Christian belief in God is not based on God blocking every avenue of doubt, but rather on God doing enough—both in our hearts and in the world—to elicit faith.

[19]The translation here is actually my own paraphrase.