GOD, CHANCE AND PURPOSE

Can God Have It Both Ways?

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Contents

CHAPTER 1

What is the problem?

The problem is to reconcile the central place which chance has in the scientific account of the world with the theological account of God's relationship to the world. Chance suggests lack of purpose; theology speaks of purpose. This long-running source of tension has come to the fore again in the claims of the Intelligent Design movement, which aims to eliminate chance in favour of design. Quantum theory, which places chance at the heart of matter, poses essentially the same question for theologians. This chapter sets the scene and, very briefly, points the way to a solution which lies in seeing chance within, not outside, the providence of God.

CHANCE VERSUS GOD

Chance has become a major weapon of those who regard science and theology as locked in mortal combat. On the theological side there are those like Sproul,[1] who signals his intentions in the title of a book *Not a Chance* (1994). The subtitle makes

[1] Dr R. C. Sproul is an American theologian in the strict Calvinist tradition. He is a prolific author and the chairman of Ligonier Ministries, which he founded. The book, from which these quotations come, appears to be his only excursion into the science and religion field though his argument is primarily directed against what he perceives to be the faulty logic used by mainstream scientists. The quotations used here were chosen because they express, with great clarity, an extreme position adopted by some Christians.

his intentions doubly clear: *The Myth of Chance in Modern Science and Cosmology*. In the preface he goes on to say 'this book' may be viewed as a diatribe against chance. 'It is my purpose to show that it is logically impossible to ascribe any power to chance whatever.' As if that did not make his intentions clear enough he continues, on page 3, 'If chance exists in its frailest possible form, God is finished . . . If chance exists in any size, shape or form, God cannot exist.'

These are strong words indeed and one can only marvel that such an annihilation can be accomplished in hardly more than two hundred pages. Sproul is not alone, of course, though few other protagonists claim quite so much. Overman[2] is another who has entered the lists with his *A Case against Accident and Self-organization* (1997). This is a more sharply focussed attack and with more technical apparatus, but its intention is much the same. Those unfamiliar with the probability logic involved may be easily impressed when he concludes: 'The probability of chance causing the formation of a universe complete with life and the first forms of living matter is less than the mathematical impossibility at the accepted standard of 1 in 10^{50}' (p. 181). It is not clear where he acquired this 'accepted standard' or who accepts it! We shall return to the matter of very small probabilities later.

[2] Dean L. Overman is a distinguished lawyer based in Washington DC. The foreword to his book was contributed by Wolfhart Pannenberg and there is a commendation on the flyleaf by Alister McGrath. The laudatory remarks on the dust cover include quotations from Owen Gingerich and John Polkinghorne. It seems generally agreed that this is a detailed and clear approach to a very important topic, but endorsement of the conclusions reached is not so easy to find. In my judgement the central conclusion, like many of its kind, is based on a fallacious probability argument as will be shown later.

From the science side there are equally forceful advocates *for* chance. Although it was written more than thirty years ago, Jacques Monod's *Chance and Necessity* remains one of the most eloquent statements of the contrary view. Although often quoted, it bears repetition.

> We say that these events are accidental, due to chance. And since they constitute the *only* possible source of modifications in the genetic text, itself the *sole* repository of the organism's hereditary structures, it necessarily follows that chance *alone* is at the source of every innovation, of all creation in the biosphere. Pure chance, absolutely free but blind, at the very root of the stupendous edifice of evolution: this central concept of modern biology is no longer one among other possible or even conceivable hypotheses. It is today the *sole* conceivable hypothesis, the only one compatible with observed and tested fact. And nothing warrants the supposition (or the hope) that conceptions about this should, or ever could, be revised. (1970, p. 110; trans. Wainhouse 1972)

Oddly enough, both sides agree that chance eliminates God. Sproul's remedy is to oust chance; Monod's, to do the same to God.

The object of this book, roughly speaking, is to bridge the gap by saving Sproul's theology and Monod's science using chance as the link between them. Sproul was wrong in seeing chance as a threat to the sovereignty of God and Monod was wrong in seeing chance as eliminating God. These are strong claims and their justification rests, essentially, on the claim that chance must be seen as lying *within* the providence of God and not outside it.

As I pause to draw breath it is pertinent to remark that whatever chance is, it is certainly not an agent capable of *causing* anything, as Overman supposes. Even such a careful writer as Dowe (2005) falls into this trap when he writes 'If the latter is true God does not cause any event caused by chance'

(p. 184). But there is a broader field to survey before we return to this matter.

The essential problem is how to accommodate within a single world-view the element of real chance, which science seems to require, and the existence of a God who is supposed to be actively involved in creating and influencing what happens in the world.

A good deal clearly hangs on what we mean by *chance*. This is not such an easy matter as it may seem and it forms the subject of chapter 2. A chance event arises when something happens which we could not predict, but this may be because we do not have enough information. Chance is then the other side of the coin to our ignorance; this is sometimes called *epistemological chance*. Alternatively, chance may be *ontological*. That is, it is somehow inherent in the nature of things and there is no knowledge we could possibly have which would make any difference. This brings us to the crucial issue of God's involvement in the world because this depends on what view we take on the nature of chance.

Nevertheless there are some situations where we do not need to answer the deep philosophical questions. In particular, these arise when we come to *calculate* probabilities. The theory of probability is not so much about what probability *is* as about how to make probability calculations about uncertain happenings. Any attempt to calculate the probability that life would appear on earth, for example, depends upon putting together the probabilities of simpler, constituent events which were necessary for life to appear. This is where Overman, and many like him, have gone wrong.

Next there are rather crucial questions about what is implied by the existence of chance happenings in the world. It is commonly assumed to be self-evident that any intrusion of chance will lead to unpredictability and uncontrollability. This is not

necessarily so and quite the opposite may be true. We shall discover that there may be extreme constraints which render the outcome of some chance processes almost certain. There is also an important matter of *levels*, to which we come in a moment, where what is uncertain at one level may be virtually certain at another level. Dying, for example, is still a highly unpredictable matter for individuals, but insurance companies and undertakers make a steady living out of it because what is individually uncertain is highly predictable in the aggregate.

There are equally weighty questions to be raised on the theological side about the nature of God. It was Sproul's determination to defend the sovereignty of God that led him to conclude that chance was impossible in God's world. Is it really true that absolute sovereignty requires that God knows and controls every one of the trillion upon trillions of events that occur in the universe every second? Might it not be that such a view actually diminishes the greatness of God? I shall, in fact, argue that this is the case.

More important, perhaps, is the effect which uncertainty in the world has on what God can know – his omniscience. Can he know, for example, what is as yet undetermined? Can we be truly free in a world in which God controls every single thing? I raise such questions now merely to show that the chance issue is not peripheral, but goes to the heart of age-old questions which have become even more pertinent in a scientific age than they were in the early centuries after Christ, or even in the Middle Ages.

New questions arise which can only be phrased in the language of chance or risk. We have to ask not merely whether God can cope with chance or even use it to good effect, but whether it might have a more positive role. After all, we use chance in large-scale computer modelling to mimic the uncertainty of the world, and to achieve goals which lie beyond

our reach without it. If we find that risk taking can be beneficial and not always a necessary evil, may this not open new perspectives for theology? Can we conceive of God as a risk taker? This is, perhaps, the key theological question and we return to it in chapter 14.

Chance and providence go together in popular debate because each seems to be at variance with the other. How can God act providentially in a world if it is not wholly under his control? This question is distinct from, but not unrelated to, the question of whether and how God can act in the lawful world revealed by science. What kind of a place the world is also affects what we can know about it. If there is genuine uncertainty about what we observe, then presumably there is some uncertainty about what we can infer about it. More especially, and challenging perhaps, is the question of what we can know about God and his purposes for us and the whole creation. Are there any certainties left for the believer or, indeed, the unbeliever?

Next, there is the relationship between chance and law. The two seem to be in direct opposition but this is not necessarily true. In fact some laws have been correctly described as statistical, or probabilistic. These are laws which relate to large aggregates and thus operate at what I have called a different level. The simplest possible example is the tossing of a coin. The outcome of a single toss is a highly uncertain matter but the outcome of 10 million tosses is highly predictable in the sense that we can say that almost exactly 50 per cent of all tosses will be heads and, furthermore, we can also be precise about what deviation from that average figure is likely to be. The constancy of such ratios certainly has the law-like characteristic we expect in dealing with a system of divine origin and concern. The gas laws are a more interesting example, where the relationship between the pressure and volume of a gas at

a constant temperature is simply determined by the average effect of a very large number of gas molecules. Lawfulness at the higher level of aggregation is thus the direct consequence of complete randomness at the lower level.

This intimate relationship between levels of aggregation also works the other way round: lawfulness can give rise to chaos. The word chaos is used here in its technical sense but, for present purposes we can think of it as, more or less, equivalent to chance. Very simple, law-abiding processes can give rise to chance. The subtlety of these relationships emphasises that what we see in the world depends on the level at which we enter it to make our observation. The same is true in the realm of physics where, as we shall see, the quantum world seems very different to the everyday world viewed on the human scale.

As we unravel the complexities of these relationships it will become apparent that Sproul's and Overman's categorical statements are not so much wrong as inapplicable to the world in which we actually live, or to the God who created and sustains it.

LEVELS AND SCALES

Before we go any further I must digress to expand on something which has already cropped up several times and which is central to the question of God's sovereignty.[3] What we observe in the world, and how we describe it, depends upon how big

[3] The idea of levels and scales occurs in other contexts. A recent example is provided by *The View from the Centre of the Universe* by Primak and Abrams (2006). The prime object of that book is to argue that, in a certain sense, we are at the centre of things and that gives us significance as humans. For example, humans are at the centre of the scale of size. If length is measured in orders of magnitude (that is powers of ten) then lengths on the human scale come somewhere near the middle of the range which extends from the smallest things we know (the Planck length of 10^{-33} cm) to the

or small a scale we view it on. The world viewed through a microscope is very different from what we see through a telescope. On the astronomical scale we simply do not notice the biological details of nature. The microscopic world has no place for mountains and trees. They are too big to be viewed on such a small scale.

If we go to the limits of size, in either direction, the worlds we find are beyond our imagining and the best we can do is to describe them by mathematical equations. On the very large scale, the Euclidian geometry of the schoolroom lets us down and we then have to reckon with things moving close to the speed of light. Space has to be thought of as curved and we find ourselves in a world in which Newton's physics is inadequate and our imagination fails.

Something similar occurs at the smaller end of the scale where we get down to the level of atoms and what goes on inside them. It is an unfamiliar world in which our intuitions based on the everyday world simply do not work. The mathematics continues to work perfectly and delivers results which are entirely consistent with the world as we perceive it at our level, but any attempt to picture it fails.

For practical purposes, we can think of three levels. First, the everyday world of things that we can see, touch and handle, where distances are measured in metres or miles – but not in

largest (the distance of the cosmic horizon of 10^{28} cm). Similarly, if less convincingly, human life has occurred in the middle of time measured from the beginning to end of the universe or the life of the earth. The important thing, from the present perspective, is that according to the authors, certain questions only have meaning – and hence meaningful answers – if posed at the appropriate level. This idea is applied in many fields including the nature of God. 'God' must therefore mean something different on different size-scales yet encompass all of them. For example, all-loving, all-knowing, all-everything-else-we-humans-do-only-partially-well may suggest God-possibilities on the human size-scale, but what about all the other scales? What might God mean on the galactic scale, or the atomic?

light years – where weight is measured in pounds and tonnes, and so forth. This I shall often refer to as the *human level*, or scale.

Secondly there is the world of the very small – too small to be observed by the naked eye – the world of cells, molecules, atoms and electrons. At best we can only see parts of this world through microscopes but often what is going on has to be observed indirectly through the observable consequences of what is happening at the micro level beyond the limits of our direct observation. This may conveniently be designated the *micro level*.

Finally, there is the world of the very large where, for example, masses can be so large as to produce observable deflection of a beam of light. In this world we encounter incomprehensibly large numbers and unimaginably long periods of time. This I shall call the *macro* or *cosmic level*. We can sometimes be helped to grasp the significance of these things if they are scaled down to something we can understand. For example, the relative distances between the planets in the solar system can be represented by where they would appear if they were laid out on a football pitch with the distances between them in the same proportions.

The concept of scale or level is central to understanding the place that chance occupies in the grand scheme of things. For example, what appears chaotic at one level may reveal a pattern when viewed on a larger scale.

This phenomenon is familiar to computer users through the zoom-in and zoom-out facility which many computers offer. As we zoom in we see more and more of the detail and less and less of the overall picture. Conversely, when we zoom out the reverse is true. This is very obvious when viewing a map. At the lower level we see individual streets, whereas at the higher level these merge into a blur as the shape and location of the town becomes the dominant feature. When viewing text

at large magnifications we lose sight of the words and notice only the patchiness of the individual letters. When we take the broader view, the words disappear and we begin to see the pattern of the layout and so on. Each view shows a different aspect of reality.

In our world it is natural to think in terms of the human scale on which we live our lives and form our understandings and intuitions. It is in this world that we form our concepts. It is in this world that Christians believe God revealed himself on a human scale. The truth thus revealed makes sense to us because it is on *our* scale. It does not follow, of course, that God's actions can be necessarily or exclusively understood at our level. In fact, as we shall see later, there have been valiant attempts to account for God's providential action by reference to happenings at the micro level.

Since, presumably, God and his creation are not commensurable we must be very wary of creating a God in our own image and on our own scale. The intimate connection between chance and order at different levels of the creation, which has been noted above and which I shall explore later, make it very important to be careful about how we use language. To suppose arbitrarily that God's main sphere of action is at the level we can most easily comprehend may be a dangerous and misleading assumption. This is relevant to two issues which are of great interest in themselves and which have brought chance to the fore in contemporary debates.

INTELLIGENT DESIGN

One of the most extraordinary phenomena to have arisen on the science and religion scene in the last few decades is the Intelligent Design[4] movement. This is largely an American

[4] There is an immense literature on Intelligent Design. In this present book we are concerned only with the logic of the argument by which, it is claimed,

phenomenon and it is fed by the peculiar mix of fundamentalisms which flourish there. In a sense it springs from the acute concerns of those, such as Sproul, who fear that chance strikes at the root of Christian belief. The great enemy, as its protagonists see it, is the naturalism of modern science. This refers to its attempt to explain everything that happens without recourse to any external direction such as is traditionally supplied by God. Chance and necessity, in Monod's memorable phrase, account for everything. Even well-meaning Christians, who see evolution as God's way of creating things, are deluding themselves, opponents would argue, and they are embarked on a path which will inevitably leave no room for God. Methodological naturalism is also viewed with great suspicion. This is the strategy of proceeding *as if* everything could be explained without reference to any external creator or designer. For if you really believed that there is clear evidence of design in the world it would be foolish to ignore it, as a matter of policy, and so have to compete with one hand tied behind your back!

The search for evidence of Intelligent Design, which I shall examine in some detail in chapter 7, involves the attempt to eliminate chance. If this could be done, design would remain as the only, and obvious, explanation. Intelligent Design assumes

chance can be eliminated as an explanation of evolutionary development. William Dembski has developed this single handedly and his work, therefore, is the focus of our attention. A fuller account would have to take note of the work of Michael Behe, especially his *Darwin's Black Box: the Biochemical Challenge to Evolution* (1996). Another key figure is Phillip E. Johnson, also a lawyer. It is pertinent to note that lawyers approach things in a rather different way to scientists. Lawyers operate in an adversarial context where their object is to detect and expose the weaknesses in the opponent's case. Science is an ongoing activity in which the well established and the provisional often exist side by side. It is not too difficult to find weak points in any scientific theory. This is a valuable thing to do but it does not establish what is true or false in any absolute sense.

at the outset that chance and design cannot coexist and this claim is totally contrary to the thesis advanced in this book. If the Intelligent Design movement were to be successful, the ideas to be set out here would be completely undermined. It is therefore essential to examine the logic of the arguments of those, such as William Dembski, whose highly technical treatment of inference under uncertainty underpins the whole enterprise.

At this and other points on our journey it will therefore be necessary to examine the logic of inference under uncertainty. It is to Dembski's credit that he recognises the need to provide a rigorous account of what is needed to eliminate chance as an explanation of any phenomenon. He also recognises that much of the groundwork has already been done by statisticians and he cites Sir Ronald Fisher[5] as one of those who have paved the way for his own new developments. Unfortunately for him, Dembski's ambitions founder not only on the faulty logic of his inference procedure but on the calculations necessary to implement it.

DOES GOD ACT IN THE WORLD?

When we look at the world on the very small scale there is a whole new territory on which to debate the role of chance. Oddly, this field does not appear to have had any serious interaction with the evolutionary issues which have so exercised

[5] Sir Ronald Fisher was, perhaps, the leading statistician of the twentieth century, though some of his ideas, including those on significance testing, were controversial and are not widely accepted today in their entirety. He was, successively, Galton professor of Eugenics at University College London and Arthur Balfour professor of Genetics in the University of Cambridge. A full account of his life will be found in his daughter's biography: *R. A. Fisher, the Life of a Scientist* (Box 1978).

the debaters of Intelligent Design. Classical mechanics has been very successful in describing the dynamics of the world of everyday objects such as tables and tennis balls but when we look at things on the scale of electrons and photons it breaks down. In that case we need quantum mechanics, which was specially developed for work at that level. Using quantum theory it is possible to be quite precise about calculations made relating to quantum phenomena. The trouble is that the theory provides an incomplete description of reality at that level. This is of no great inconvenience to physicists, who can make their calculations regardless, but it poses serious questions for philosophers and theologians. The latter, especially, want to know what is really going on, so that they can examine whether it is an appropriate arena for the action of God. There are competing interpretations of what the quantum world is actually like, and it is those that incorporate an element of chance that fall within our present concerns.

At one extreme are those who prefer a wholly deterministic interpretation of the quantum world. This is possible, if somewhat contrived, and it certainly fits in with the worldview of theologians such as Sproul. At the other extreme, what is prescribed are probabilities. According to that view, the individual events can then occur as God wills provided that, in aggregate, they conform to the overall probabilities. One way of describing this situation is to say that we only know the quantum world through probability distributions. This enables us to predict where particles are and what they are doing probabilistically but these distributions do not provide definitive information about what is actually the case. So chance is seen as a positive asset because it provides room for manoeuvre for a God intent on purposeful activity. Chance is then not the enemy of theism but necessary for it to be credible. The problem posed by the possibility of God's acting in

quantum events is not essentially different from his action in relation to any statistical law. This will be a recurring theme in the following chapters.

GOD'S CHANCE

In chapter 11 we come to the heart of the matter and I argue for the view that chance is a deliberate part of God's creation. Not only is the presence of chance an integral part of the created order but it actually offers possibilities of variety, flexibility and interest which would not be available in a deterministic universe. This contention does not, of course, sweep all opposition before it. There remains a cogent case to be made in defence of a more traditional theology. However, this is not to be found by following Sproul, Overman and others down the road of anti-science or of pseudo-science. It is more likely to be found in arguments such as those of Byl (2003), whose case I answer in chapter 12. But there is also a paradox in introducing chance as a way of providing freedom of choice and then having to reckon with what this does for the rationality of human choosing. This is the subject of chapter 13. In the final chapter I deal at greater length with what I see as one of the most serious theological challenges posed by the God who works, in part at least, through chance.

CHANGING PERSPECTIVES

One can detect a progression as one moves through the debates which provide a connecting thread throughout this book. First there is the idea that chance is a problem for theology. Its perceived existence seems to challenge the sovereignty of God and call for scientific effort to be devoted to its elimination. Only when this is done will the true nature of reality be revealed.

This was the thrust of much early work designed to show that the complexity and wonder of the world revealed by science simply could not be 'due to chance'. Overman cites many examples. Some of this work is reviewed in chapter 6 but this line of thinking finds its culmination in Dembski's approach to Intelligent Design treated in chapter 7.

In the second stage chance has a more benign role. It is seen as playing an essential, but passive, part in providing the space for God to act without disturbing the lawfulness of the world. The trouble with the fully deterministic system, which a rigorous view of God's sovereignty seems to require, is that it leaves no room for free action either on God's part or our own. If we can create space for free actions, without disturbing the order in nature or requiring God to contradict himself, then progress will have been made. Quantum theory, according to some interpretations, appears to allow just the flexibility that is called for.

More generally, the widespread occurrence of statistical laws in nature and society seems to provide further room for manoeuvre for both God and ourselves.

Neither of these two approaches is satisfactory and a substantial part of this book is devoted to exposing their weaknesses and preparing the ground for what I believe is a more adequate view. This sees chance in a more positive light, as something which actually does greater justice to the sovereignty of God and to his remarkable creativity. Freed from an excessively 'mechanical' way of thinking about God's actions, we see an enormously rich tapestry of opportunities and possibilities in the creative process. In short, chance is to be seen as within the providence of God rather than outside it. It is a real part of the creation and not the embarrassing illusion which much contemporary theology makes it out to be.

CHAPTER 7

Can Intelligent Design be established scientifically?

Intelligent Design has been proposed as a credible scientific alternative to the theory of evolution as an explanation of life on earth. Its justification depends on an extension of Fisherian significance testing developed by William Dembski. It is shown, in this chapter, that there is a fatal flaw in the logic of his method, which involves a circularity. In order to construct a test to detect design and 'eliminate' chance, one has to know how to recognise design in the first place. Dembski's calculation of the probability required to implement the method is also shown to be erroneous.

WHAT IS THE ARGUMENT ABOUT?

Intelligent Design is at the centre of one of the fiercest debates currently taking place in the science and religion field. Its proponents claim that the scientific establishment is set on an atheistic course by refusing to countenance the possibility that the world might contain evidence of design. All they ask is that design should not be arbitrarily ruled out from the start and that nature should be allowed to speak for itself; no special privileges are asked for. The whole debate should then take place within the bounds of science and according to its principles of rationality.

The opponents will have none of this, claiming that Intelligent Design makes no claims that can be tested empirically

and, because it cannot be falsified, it is not science. Many see it as crypto-creationism masquerading under the guise of science. They suspect that it is a scientific front for an ideology whose aims are more sinister and which are carefully concealed.

The United States of America is the birthplace and home of Intelligent Design[1] and it is out of the heady mix of a conservative fundamentalism and the threat of religion's trespassing into education that the heat of the debate comes. If evolution is 'only a theory' then why, it is argued, should not other theories get 'equal time' in education? After all, should not children be given the opportunity to make up their own minds on such an important matter and should not their parents have a say in what their children are taught? The proponents of Intelligent Design, it is alleged, wear the clothes of liberals pleading that all sides should be given a fair hearing, whereas, from the other side, the scientific establishment is presented as a group of reactionaries seeking to control what is taught.

[1] There is an enormous literature on this topic, much of it highly controversial. It is difficult to select a few articles as background reading. A broad, if uncritical, survey will be found in O'Leary (2004) about a quarter of whose book consists of notes, which reflect the author's wide reading. O'Leary is a journalist who makes no pretence of being an expert in science. Her sense of fairness doubtless leads to her tendency to grant 'equal time' to all sides of an argument. This means that minority viewpoints may appear, to the uninitiated, to carry more weight than they ought. This is true, for example, of the few creationists who have scientific qualifications. The far more numerous members of the scientific establishment are treated with less sympathy. A more academic treatment will be found in Peterson (2002). The journal *Perspectives on Science and Christian Faith* (the journal of the American Scientific Affiliation) has carried two extensive debates that reflect the divisions on the subject among more conservative Christians: volume 54 (2002): 220–63 and volume 56 (2004): 266–98. Much of the technical material is due to William Dembski and this will be referred to in the course of the chapter.

This is not a private fight confined to one country but, since it goes to the heart of what is true in both science and religion, anyone may join in. Those who start as spectators may well see more of the game (to change the metaphor) and so have something to contribute.

The main thesis of the Intelligent Design movement runs counter to the central argument of this book. Here I am arguing that chance in the world should be seen as *within* the providence of God. That is, chance is a necessary and desirable aspect of natural and social processes which greatly enriches the potentialities of the creation. Many, however, including Sproul, Overman and Dembski, see things in exactly the opposite way. To them, belief in the sovereignty of God requires that God be in total control of every detail and that the presence of chance rules out any possibility of design or of a Designer.

To such people, the fact that evolution by natural selection involves chance in a fundamental way appears to rule out the design and purpose without which the whole theistic edifice collapses. Defence of theism thus involves showing that chance is non-existent or, at best, is no more than a description of our ignorance. It is allowed to have no ontological status at all. The Intelligent Design movement is dedicated to showing that the world, as we know it, simply could not have arisen in the way that evolutionary theory claims. This is not to say that evolution by natural selection could not have played some part, but that it could have done so only in a secondary manner. The broad picture could not, they argue, have come about without the involvement of a Designer. In this chapter I shall examine the claim that it can be rigorously demonstrated that chance does not provide a sufficient explanation for what has happened. I shall not be directly concerned with other aspects of Dembski's argument, in particular his claim that information cannot be created by chance.

Essentially, there are two matters to be decided. Is the logic of the argument which, it is claimed, leads to the 'design' conclusion valid and, if it is, are the probability calculations which it requires correct? The logic is effectively that of significance testing outlined in the last chapter. According to the chief theoretician among the proponents of Intelligent Design, William Dembski, the logic is an extension of Sir Ronald Fisher's theory of significance testing. Given Fisher's eminence as a statistician, it is appropriate that his voice should be heard on a matter so close to the core of his subject. Probability calculations also come under the same heading, so I shall examine how Dembski made his calculations.

William Dembski has single-mindedly pursued his goal of establishing Intelligent Design as a credible alternative to evolution in several major books and a host of other articles, books and lectures. This publication trail started with *Design Inference*, in which he set out the basic logic of eliminating chance as an explanation of how things developed. This was followed by *No Free Lunch* and *The Design Revolution* (Dembski 1998, 2002 and 2004).[2] The latter book is subtitled *Answering the Toughest Questions about Intelligent Design* and is, perhaps, the clearest exposition of his basic ideas for the non-technical reader. He has also collaborated with Michael Ruse in editing *Debating Design; From Darwin to DNA* (Dembski and Ruse 2004).

Much of Dembski's argument is highly technical, and well beyond the reach of anyone without a good preparation in mathematics, probability theory and logic. This applies as much to the material written for a general readership as to

[2] In *Zygon* 34 (December 1999): 667–75, there was an essay review by Howard J. van Till of both Dembski (1998) and Overman (1997). This is in substantial agreement with the views expressed in this book. Van Till's review was followed by a rejoinder from Paul A. Nelson on pp. 677–82.

the avowedly technical monograph which started it all off (Dembski 1998). In one sense this is highly commendable, because the clarity and rigour which can be attained by this means offers, at least, the prospect of establishing the ideas on a secure scientific foundation, so that the debate can take place within the scientific community.[3] However, this fact poses a serious dilemma for anyone who wishes to engage with him. If the case against Intelligent Design is made at too high a level, it will pass over the heads of many of those who most need to question it. If it is too elementary, it will fail to treat the opposition seriously enough. One must also bear in mind the psychology of the readership. A highly technical treatment can have two opposite effects. On the one hand there is the tendency, on the part of some, to put undue trust in mathematical arguments, thinking that anything which is beyond their reach is also beyond question and almost certainly correct! On the other hand, others may dismiss it instantly as they dismiss all such material, on the grounds that what cannot be expressed in simple everyday language can be ignored as esoteric nonsense. Neither view is correct in this case. The extensive theoretical treatment cannot be so easily dismissed, but neither should it be swallowed whole.

DEMBSKI'S ARGUMENT

To do justice to the subtleties of Dembski's arguments we shall have to take things fairly slowly, but the reader may be

[3] The two opposite reactions mentioned in this paragraph will be familiar to anyone who, like the author, has attempted to explain technical – especially mathematical – matters to lay audiences. As noted in the preface, the problem is acute in a book such as this. It often is a case of being 'damned if you do and damned if you don't'.

grateful for a simple statement at the outset of the essence of the situation.

The universe is very large and very old, so there has not been either enough time or enough space for some exceptionally rare events to occur. Roughly speaking, Dembski claims to be able to calculate the probability of the rarest event one could have expected to happen 'by chance' somewhere at some time. It is simply not reasonable to expect any chance event with smaller probability to have occurred at all. Hence if we can find existing biological entities, say, whose probability of formation by chance is less than that critical bound, we can infer that they could not have arisen by chance. Hence they could not have arisen by evolution if that process is driven by chance. Dembski claims that at least one such entity exists – the bacterial flagellum – and that suffices to establish design and, necessarily, a Designer.

It is important to notice that the 'design' conclusion is reached by a process of elimination. According to Dembski there are only two other possible explanations: natural law or chance. Once these are eliminated, logic compels us to fall back on design. It is not often noted that the entity must not only be designed but also brought into being.[4] There must, therefore, be a Maker as well as a Designer. Since natural law can be regarded as a special, but degenerate, case of chance the main thing is to eliminate chance. That is exactly what a Fisherian significance test was designed to do.

THE ELIMINATION OF CHANCE

It can never be possible to eliminate the chance explanation absolutely. The best we can do is to ensure that our probability

[4] Howard van Till is an exception. Van Till distinguishes 'the *mind-like* action of *designing* from the *hand-like* action of *actualising* . . . what had first been designed' (2003, p. 128).

of being wrong, when we claim to have eliminated chance, is so small that it can be neglected. Dembski believes that Fisher essentially solved this problem but that his procedure had two gaps which can be closed. When this is done, the way is clear to reach the goal.

I shall begin by recapitulating the basic idea of a test of significance, which starts from the assumption that chance is the explanation and then seeks to demonstrate that what has happened is not consistent with that hypothesis. This time, however, I shall use what is, perhaps, the simplest possible kind of example which still facilitates comparison with what Dembski actually does. We have already seen this example, discussed by John Arbuthnot in chapter 6 on sex determination. Here, as he did, we suppose that the probability of a female birth is exactly 0.5, independently of all other births. In other words, it is just as if sex was determined by coin tossing.

Suppose we have a sample of eight births. The first step is to list all possible outcomes. One possibility is that they all turn out to be male, which we might write as MMMMMMMM; another would be MFMMFFMM, and so on. Altogether there are $2^8 = 256$ possibilities. The next step is to calculate the probability of each outcome. Because of the simple assumptions we have made they all have the same probability of 1/256. The final step is to construct a rejection set such that any occurrence in that set will lead us to reject the hypothesis. Since we do not wish to reject the hypothesis when it is actually true, the probability of falling in this set should be small. One possible way to do this would be to make our rejection set consist of the two outcomes MMMMMMMM and FFFFFFFF, that is: all male or all female. It seems clear that if one of these goes in, the other should too, because they represent equivalent departures from what one would expect – roughly equal numbers of males and females. The probability associated with this set

of two outcomes is 1/128, which is not particularly small but it will serve for purposes of illustration if we treat it as 'small'.

If we now adopt the rule that we will reject the chance hypothesis whenever we observe *all males* or *all females* in a set of eight births, we shall wrongly reject the hypothesis one time in 128. Is this a sensible procedure? It certainly ensures that we shall rarely reject the chance hypothesis when it is, in fact, true but that would be the case for any set of two outcomes we might happen to select for the rejection set. What is required, it seems, is a rejection set which has both small probability *and* which 'catches' those outcomes which are indicative of non-randomness or, in Dembski's terminology, design. At this point there is some divergence between Dembski and the traditional statistical approach, as represented by Fisher. It will be instructive to look at these two approaches in turn.

The Fisherian would want to include in the rejection set those outcomes which were 'furthest' from 'chance', in some sense, that is, from what the hypothesis under test predicts. If the probability of a male birth is really 0.5 we would expect around four males in every eight births. An all-male or an all-female outcome would be the most extreme and these would be the first candidates for inclusion in the rejection set. Next would come those with only one male or female, then those with two, and so on. The process would stop when the probability of the rejection set reached the value we had chosen as the small probability that we had set as the risk we were prepared to run of wrongly rejecting the chance hypothesis.

To the end of his life Fisher thought that his procedure just described captured the essence of the way that scientists work, though he strongly objected to the idea of rejection 'rules'. He preferred to quote the *significance level*, which was the size of the smallest set which just included the observed sample. Nevertheless, the distinction is not important for present

purposes. Other, perhaps most, statisticians, came to think that more explicit account should be taken of the alternative hypotheses which one was aiming to detect. This was done implicitly in the sex ratio example by constructing the rejection region starting with those samples whose proportion of males, and hence females, was furthest from 0.5. Neyman and Pearson extended the theory to one which bears their name, by arguing that the rejection set should be determined so as to 'catch' those outcomes which were indicative of the alternatives envisaged. Thus, for example, if one were only interested in detecting a tendency for males to be more common, then one would only include outcomes where male births predominated.

It is in choosing the critical region that Dembski's aim is different. He is looking for outcomes which show evidence of design, so his critical region needs to be made up of those outcomes which bear evidence of being non-random. One example of such an outcome would be MFMFMFMF. As male and female births are precisely equal, this outcome would not be allocated to the critical region in the Fisherian approach. This difference directs our attention to the fact that Dembski is actually testing a different hypothesis. In our example, the hypothesis concerned the value of the probability – whether or not it was 0.5. The question we were asking was: are the outcomes consistent with births being determined at random and with equal probability, in other words, just as in coin tossing? Dembski is not concerned with the value of the probability but with the randomness, or otherwise, of the series. It is not altogether clear from his writing whether Dembski has noticed this distinction. He does, however, recognise that the Fisherian scheme needs to be developed in two respects to meet his needs. First he notes that one has to decide what counts as 'small' in fixing the significance level. Dembski claims to

have an answer to this question and we shall return to it below. The other point, which is germane to the discussion of how to select the rejection region, is that Dembski wishes to eliminate *all* chance hypotheses not, as in our example, just the one with probability 0.5.

Although it is not totally clear to me how Dembski thinks this should be handled, it is implicit in much of his discussion. Essentially he wishes to include in the rejection set all those outcomes which show unmistakable evidence of design. He calls this property, *specified complexity*. An interesting way of approaching this is through the work of Gregory Chaitin and his way of measuring non-randomness, which I have already discussed in chapter 4. Outcomes exhibiting specified complexity will score highly on a measure of non-randomness and so will be candidates for inclusion. Of all possible outcomes it is known that almost all of them appear to be random, so the proportion which show some pattern form a vanishingly small set which must, inevitably, have small probability. Dembski's approach is slightly different in that he sometimes appears to use 'small probability' as a proxy for 'specified complexity'. This is plausible if one thinks that anything which is designed is bound to be virtually impossible to construct by chance alone and hence must have an exceedingly small probability. Constructing a rejection region by first including outcomes with the smallest probabilities will thus ensure that we only reject the chance hypothesis in favour of something which has specified complexity. However, while it is true that any outcome exhibiting specified complexity will have small probability, the converse is not necessarily true.

All of these ideas are put to the test when we come to consider particular examples, and for Dembski, that means the bacterial flagellum. But first we must return to the question of what is meant by 'small' in this context.

THE UNIVERSAL PROBABILITY BOUND: HOW SMALL IS SMALL?

According to Dembski, one of the defects of Fisherian significance testing is that it does not say what is meant by 'small' when choosing a significance level. He provides an answer to this question in what he calls the *universal probability bound*. The idea is very simple; the calculation less so. The idea is that the universe is simply not old enough, or big enough, for some events to have materialised anywhere at any time. To put a figure on this requires a calculation of how many events of specified complexity could have occurred. This leads to what Dembski calls the universal probability bound of $1/10^{150}$. I shall not go into the details of his calculation but it depends, for example, on the number of elementary particles in the universe (10^{80}), the rate at which changes can take place, and so on.

It is worth pausing to reflect on the extreme smallness of the probability that I have just been talking about. The number of elementary particles in the universe is, itself, unimaginably large. It is difficult enough to imagine the number of stars in the universe but this difficulty is compounded by the fact that every single star is composed of a vast number of elementary particles. Even when all these are added up we are still many orders of magnitude short of the number 10^{150}. The only point of raising this issue is to turn the spotlight onto the importance of getting the calculation right, if what we are going to do next is compare our calculated probability with some infinitesimally small bound.

The calculation is not straightforward. Although we shall not go into details, there are a number of pitfalls in making such calculations, which Dembski avoids, even though he has to invent a whole new terminology to express what he is

about. To begin with, Dembski finds it necessary to introduce the notion of what he calls *probabilistic resources*. This has to do with the fact that there may have been many opportunities at many places for a particular event to occur. So the question we ought to be asking is not whether that event occurs exactly once, but at least once. Another difficulty is that there is simply not always enough information to make an exact calculation. It is sensible, however, to err on the safe side, so Dembski's final answer is not, therefore, an exact figure but a lower bound. This means that the true figure cannot be smaller than this bound, but may be higher. So if, when we make a comparison with another probability, that probability turns out to be smaller than the bound, it will certainly be smaller than the true figure.

There is one more important aspect of Dembski's argument to which we should pay attention. He proposes that the rejection set should consist of the specifically complex outcomes. At this point we run up against the fact that Dembski sometimes appears to regard a rejection set as consisting of one outcome but this is not strictly true. Just as he introduces the idea of probabilistic resources so he introduces *structurally complex* resources. The former allows for the fact that an event which has only a very small probability of occurring at a particular time and place will have a much larger probability if it can occur at many places and times. Similarly, the latter allows for the fact that there may not be just one structurally complex outcome but a number. The probability of observing at least one of them is, therefore, larger than that of exactly one. In effect this means that we have a rejection set consisting of several outcomes just as I supposed in describing the Fisherian significance test.

If we let this collection of specifically complex outcomes constitute the rejection set, we will achieve two objectives at

once. First, since the set of specifically complex outcomes is very small, its size (probability) will also be very small, thus meeting the first requirement of a test of significance. Secondly, if we reject the chance hypothesis whenever the outcome falls in this set, we shall never make an error of Type II (false negative). This is because every element in the rejection set is certainly indicative of design, by definition. That is, we may ascribe design to the outcome in such cases without any risk of making a mistake. This is exactly what Dembski wishes to achieve.

A moment's reflection will show that there is something a little odd about this line of reasoning. It says that we should reject the chance hypothesis whenever the outcome exhibits specific complexity. In doing so, we shall certainly be correct if design is, in fact, present and our chance of wrongly rejecting the chance hypothesis will be very small (the size of the rejection set). However, one may legitimately ask why we need all this technical apparatus if we know already that certain outcomes exhibit design. The conclusion is, indeed, a tautology. It says that if something bears unmistakable evidence of design, then it has been designed! The nature of what Dembski is doing, and its absurdity, will be even more obvious when we set it in the context of what he calls 'comparative' methods below. First, I digress to point out the other flaw in Dembski's argument.

THE PROBABILITY OF THE BACTERIAL FLAGELLUM

Although Dembski spends a great deal of time developing a version of Fisherian significance testing designed to eliminate chance, the main application is to one particular case where the theory is not much in evidence. This concerns a remarkable biological structure attached to the bacterium *Escherichia*

coli,[5] which drives it in the manner of a propeller. The question is whether this construction could have been assembled by chance or whether its presence must be attributed to design. Dembski makes a rough calculation of the probability that this structure could have come about by chance and arrives at the exceedingly small value of $1/10^{263}$. How on earth, one may wonder, could anyone ever arrive at such a seemingly precise figure? Inevitably there have to be some approximations along the way, but he chooses them so as to err on the safe side. However, there is no need to stay on the details because the whole enterprise is seriously flawed. Howard van Till (2003) has put his finger on the source of the problem. His criticism is that Dembski's probability calculation in no way relates to the way in which the flagellum might conceivably have been formed. Dembski treats it as what van Till calls a *discrete combinatorial object*. Essentially, Dembski counts the number of ways in which the ingredients of the flagellum could be brought together and assembled into a structure. The bland, and false, assumption that all of these structures are equally likely to have arisen then yields the probability.

It is difficult to understand how such an elementary mistake can have been made by someone so mathematically sophisticated. Possibly it stems from confusion about what is meant by 'pure chance'. There are many examples in the literature of similar combinatorial calculations which purport to show that such things as the origin of life must have been exceedingly small. This has already been noted in chapter 6 in relation

[5] The case of the bacterial flagellum dominates the literature, almost as though it were the only sufficiently complicated biological organism. Later in this paragraph we come to van Till's discussion of its probability, which was the main purpose of the paper quoted in note 4 above. In strict logic, of course, only one case is needed to establish the conclusion that some things are too complicated to have evolved.

to the work of du Noüy and to Hoyle and Wickramasinghe, among others. As noted in the last chapter, no biologist has ever supposed that such complicated entities can be assembled as a result of some cosmic shuffling system. Indeed, the main point of Dawkins' book *Climbing Mount Improbable* (Dawkins 2006 [1996]) is to demonstrate that complicated structures which it would be virtually impossible to assemble as discrete combinatorial objects could be constructed in a series of small steps which, taken together, might have a much larger probability (see 'Chance in evolution' in chapter 11, below). According to evolutionary theory the growth in complexity would have taken place sequentially over immense periods of time. What is needed is a model of how this might have happened before we can begin to make any meaningful calculations. To produce an argument, as Dembski does, that the flagellum could not have been formed by an 'all-at-once' coming together and random assembly of the ingredients is hardly more than a statement of the blindingly obvious. The inference that Dembski wishes to make thus fails, even if his universal probability is accepted.

THE PARADOX

We now return to the logic of Dembski's argument. Because the fallacy is so fundamental, I shall repeat what was said above but in a slightly different way.

Dembski has always seen his approach as standing squarely in the Fisherian tradition, in which no account needs to be taken of alternative hypotheses. At first sight this seems to be a reasonable position to adopt, because any alternative hypothesis would have to be specified probabilistically and it is the express purpose of the exercise to eliminate *all* chance hypotheses. It is thus somewhat ironic that Dembski's logic can be set out quite simply within the framework of the

Neyman–Pearson approach to inference. The clarity which we gain thereby also serves to underline the essentially tautological character of the formalism.

Let us think of a situation, like the coin-tossing exercise, in which there are very many possible outcomes, each having very small probability (in Dembski's terminology these are complex). Some of these outcomes will be what Dembski calls specifically complex. These outcomes exhibit some kind of pattern which bears the hallmark of design – let us leave aside for the moment the question of whether or not 'pattern' can be adequately defined. The essence of the Neyman–Pearson approach to statistical inference is to choose the rejection set to include those outcomes which are most likely to have arisen under some alternative hypothesis. In this case the alternative is that the outcomes are the result of design. The characteristic of a designed outcome is that it exhibits specified complexity. The rejection set should therefore consist of all those outcomes.

Now let us consider the consequences of what we have done. The likelihood of wrongly rejecting the chance hypothesis is very small because specified outcomes have very small probability. The probability of correctly rejecting the chance hypothesis is one (that is, certain) because all outcomes in the rejection set are certainly the result of design (that is why they were selected). In other words, we have maximised the chance of detecting design when it is present. We thus seem to have a foolproof method of detecting design whose logic has been made clearer by setting it in the Neyman–Pearson framework (which Dembski seems to be hardly aware of). So where is the catch? The problem is that, in order to construct the rejection set, we have to be able to identify those outcomes which are the result of design. If we know that already, why do we need the test in the first place?

One possible response is to say that we only identify design indirectly through the very small probability which it assigns to some outcomes. This would suggest that the rejection region should be formed of those outcomes which have the smallest probabilities and leave, in particular, those which are less than the universal probability bound. In that case we are entitled to ask why we need the formalism at all. If the rule to follow is to reject the chance hypothesis whenever the outcome observed has probability that is so small that it could not have arisen in a universe as large or old as the one we inhabit, is that not a sufficient ground of itself?

DEMBSKI'S CRITICISMS OF COMPARATIVE METHODS

Dembski is highly critical of what he calls comparative methods and his reasons are set out in chapter 33 of Dembski (2004).[6] A comparative method is any method which involves the comparison of the chance hypothesis with an alternative. Such a method involves selecting one from several possibilities and is thus concerned with the relative rather than the absolute credibility of hypotheses. At first sight this is a surprising position to take because there clearly is an alternative in mind – that the complexity we observe is the work of a Designer. However, this alternative clearly has a different status in Dembski's mind, presumably because it is not specified probabilistically. There are three comparative methods in common use which I have already reviewed in chapter 6. The first is the Neyman–Pearson approach, which uses the alternative hypotheses to select the rejection set; the second

[6] Dembski mentions (2004, p. 242) a conference at Calvin College in May 2001 on Design Reasoning, at which he spoke. Timothy and Linda McGrew and Robin Collins are reported as putting Bayesian arguments. In particular these critics objected to the notion of *specification*.

is the likelihood method, or inference to the best explanation approach; and the third is the Bayesian method, in which the alternatives have specified prior probabilities. Dembski seems hardly aware of the first two approaches and concentrates his fire on the Bayesian threat. Possibly this is because his own treatment has been challenged from that quarter and this is where much current philosophical interest in uncertain inference lies.

I agree with Dembski's strictures on the use of Bayesian inference in this particular context primarily because the introduction of prior probabilities makes the choice too subjective. In an important sense it begs the question because we have to decide, in advance, the strength of our prior belief in the existence, or not, of a designer. Bayesian inference tells us how our beliefs should be changed by evidence, not how they should be formed in the first place. What Dembski seems to have overlooked is that his method is, in fact, a comparative method and that it can be seen as such by setting it within the framework of the Neyman–Pearson theory as demonstrated in the last section. By viewing it in that way we saw that its tautological character was made clear and hence the whole inferential edifice collapses. Given, in addition, that Dembski's probability calculation is certainly incorrect I conclude that Intelligent Design has not been established scientifically.

IS INTELLIGENT DESIGN SCIENCE?

Much of the debate over Intelligent Design has not been on its statistical underpinning but on the more general question of whether or not it is science. This usually turns on whether it makes empirical statements which can be tested empirically. Although this is true, in my view it approaches the problem from the wrong direction. To make my point it is

important to distinguish 'science' from 'scientific method'. Scientific method is the means by which science as a body of knowledge is built up. Dembski has proposed a method by which, he claims, knowledge is validly acquired. The question then is: is this method valid? That is, does it yield verifiable facts about the real world? As I noted at the outset, two questions have to be answered: is the logic sound and is the method correctly applied? To the first question my answer is that the logic is not sound, because the extension proposed to Fisherian significance testing is not adequate in itself and also because almost all statisticians find the original Fisher method incomplete because it ignores alternative hypotheses. To the second question the answer is also negative because the calculation of the key probability is incorrect. The second failure could, in principle, be put right even though the practicalities are almost insurmountable. The first failure seems irredeemable because, once we introduce alternative hypotheses, a circularity in the argument for the construction of the critical set becomes apparent. Dembski's method is not, therefore, a valid scientific method.