

# THE DESIGN INFERENCE

## ELIMINATING CHANCE THROUGH SMALL PROBABILITIES

2<sup>ND</sup> EDITION, REVISED AND EXPANDED

WILLIAM A. DEMBSKI AND  
WINSTON EWERT

SEATTLE

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## Description

A landmark of the intelligent design movement, *The Design Inference* revolutionized our understanding of how we detect intelligent causation. Originally published twenty-five years ago, it has now been revised and expanded into a second edition that greatly sharpens its exploration of design inferences. This new edition tackles questions about design left unanswered by David Hume and Charles Darwin, navigating the intricate nexus of chance, probability, and design, and thereby offering a novel lens for understanding the world. Using modern concepts of probability and information, it exposes the inadequacy of undirected causes in scientific inquiry. It lays out how we infer design via events that are both improbable and specified. Amid controversial applications to biology, it makes a compelling case for intelligent design, challenging the prevalent neo-Darwinian evolutionary narrative. Dembski and Ewert have written a groundbreaking work that doesn't merely comment on contemporary scientific discourse but fundamentally transforms it.

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# Advance Praise

Ever since Darwin, most scientists have adopted a principled view by which they reject out of hand any non-naturalistic explanations. This works perfectly well in the physical sciences, but less so in biology where, due to the incredible complexity of biological systems, appearance of design is overwhelming. Yet, by appealing to this metaphysical principle, intelligent design (ID) ideas are automatically rejected; natural selection and random mutations are viewed as the only acceptable explanation of the mechanism by which biological evolution takes place.

Though I take an agnostic position on ID, I have no doubt that its main proponents, Behe and Dembski, have brought to light important challenges to the reigning neo-Darwinian version of evolutionary biology. This second edition of Dembski's classic *The Design Inference* is well argued and eminently readable. The appendix provides the reader with a short, effective, introduction to the probabilistic and statistical methods used throughout the book. The authors give plenty of well-motivated, non-biological examples on how specified events of small probability lead to a convincing inference of intelligent design. The same arguments become controversial only when applied to biology! I don't see how any open-minded scientist can ignore this important book.

— **Sergiu Klainerman**, Higgins Professor of Mathematics,  
Princeton University, member of the National Academy of  
Sciences

When technology guru George Gilder described William Dembski as the Isaac Newton of the information age, he was in no way guilty of hyperbole. In *The Design Inference*, Dembski cracked a profound philosophical and scientific problem that had persisted unsolved for 2,500 years.

Western philosophers and scientists from Plato, Aristotle, and Cicero to Maimonides, Aquinas, and Kant to Boyle, Paley,

Maxwell, and even Newton himself have long perceived evidence of design in nature. Yet none of these great thinkers were able to explicate objective criteria by which the intuition of design could be justified.

In the first edition of *The Design Inference*, published with Cambridge University Press in 1998, Dembski explicated joint criteria of improbability and specification by which rational agents can reliably detect the activity of other rational agents. He also showed that human beings as rational agents routinely make such design inferences even if they are unaware of, or unable to, articulate the criteria by which they make them.

Now in the second edition of *The Design Inference*, writing with computer scientist Winston Ewert, Dembski trades on the same powerful concepts developed in the first edition, while providing additional analytical rigor and an updated account of the key notion of specification. In so doing, he explains how the concept of specification can be legitimately applied to a wider variety of cases.

Consequently, his work has now even more obvious and profound implications for the debate about design in biology, physics, and cosmology. Specifically, Dembski's updated account of specification makes it easier to explain why the digital code stored in the DNA molecule, and the fine tuning of the fundamental parameters of physics, exemplify both small probability events *and* specifications—and, thus, why they rightly trigger an awareness of intelligent activity or design.

This updated edition of *The Design Inference* shows the enduring power of Dembski's ideas and itself reveals the work of a profound intelligence. Clearly written, rigorous, and intellectually compelling. A work of genuine genius.

— **Stephen C. Meyer**, Director of Discovery Institute's Center for Science and Culture, author of *Signature in the Cell*, *Darwin's Doubt*, and *Return of the God Hypothesis*

Appearing a quarter century after the first edition, this second edition of *The Design Inference* is bolder, richer, and without the

burden and dictates of a doctoral dissertation. More than double in size, it is a testimony to Dembski's abiding commitment to elucidation of design in all its myriad forms. The second edition could not have come into existence without the work of the designed minds (Dembski and Ewert) who have now added a new layer to the discourse by inviting readers to reflect on the processes of evolution in addition to the products of evolution. This extension to the refreshingly restated arguments of the first edition makes this second edition a compelling refutation of the neo-Darwinian narrative; it will be a gamechanger in the discourse on whether or not life has been designed.

— **Muzaffar Iqbal**, Founder-President of the Center for Islamic Sciences, past Director of the Pakistan Academy of Sciences

Prepare to be dazzled. This new edition of *The Design Inference* is a *tour de force* of thinking and explaining—a veritable feast. If you are serious about understanding fundamental reality, evidence, and reasoning, read this book.

— **Gale Pooley**, Associate Professor of Business Management, Brigham Young University-Hawaii, co-author of *Superabundance*

Richard Dawkins famously commented that, with Charles Darwin and his theory of evolution, it became possible to be an intellectually fulfilled atheist. The “design” in nature is merely apparent, and natural selection acting on random variation explains why, according to Dawkins. Despite the likes of Michael Faraday, Gregor Mendel, James Clerk Maxwell, and Arthur Eddington, Dawkins considers modern science and traditional religious conviction to be incompatible.

Not so, and with the help of William Dembski and Winston Ewert, it has now become even more possible to be an intellectually fulfilled theist. The second edition of *The Design Inference* makes a compelling case that the “design” in nature is real and can be scientifically inferred. As they show, the specified complexity of the information contained in DNA and RNA—its small probability and conformity to a complex pattern—cannot plausibly be attri-

buted to unguided natural processes; logically and causally, it requires an intelligent designer.

As Dembski and Ewert realize, their work does not get us to the benevolent Deity of the Bible, and it will probably not satisfy die-hard fans of Darwinian selection and the quantum multiverse, including Dawkins. I highly commend *The Design Inference*, however, to anyone who wants to be intellectually informed about probability, reason, and faith.

— **Timothy P. Jackson**, the Bishop Mack B. and Rose Stokes  
Professor of Theological Ethics, Candler School of Theology,  
Emory University

Darwinists have long asserted any appearance of design in life is the result of natural unintelligent processes that had no end in mind. Any suggestion that there is a designer is merely a primitive “god of the gaps” argument from ignorance. But Drs. Dembski and Ewert show in an accessible and testable way that intelligent design is not an argument from ignorance—life itself contains empirically, verifiable evidence *for* design. And the evidence is mathematically overwhelming. Some will use their designed minds to continue to resist the conclusions of this brilliant *tour de force*, but given the evidence I suspect any resisters will be either stubborn ideologues or really bad at math.

— **Frank Turek**, President of CrossExamined.org, author and  
speaker

This second, and expanded, edition benefits greatly from the significant advances in understanding the design inference over the last twenty-five years. Over half a century ago, in *Chance and Necessity*, Jacques Monod admitted that there is a “fundamental epistemological contradiction” when we attempt to understand teleological objects “objectively.” This contradiction arises because he dogmatically insisted that objective science has no place for design. *The Design Inference* shows how meaningful events can be, and indeed are, recognized using a simple criterion: *specified complexity*. In this second edition, Dembski and Ewert carefully explain this criterion, showing how it not only helps us

understand and analyze a wide range of decisions that we make as part of everyday life, but also extends the reach of science.

— **Fred Skiff**, the Harriet B. and Harold S. Brady Chair in Laser Physics, University of Iowa

This new and expanded edition of *The Design Inference* follows in a long line of books over the last quarter century by distinguished mathematician William Dembski, renowned as the leading intelligent design (ID) specialist in the world. This book is another important step along the way to validating intelligent design as a mainstream and scientifically robust alternative to Charles Darwin's nineteenth-century philosophy of natural selection.

A key question this book addresses is: Does natural selection have sufficient creative power to account for the immense complexity and information-richness of life? To date, mainstream science has failed to answer this question. An appeal to faith in natural selection's information-creating powers—in the continued absence of clear confirming evidence of such—remains the current leading answer for information creation. But in some countries, such as Brazil, ID is making dramatic inroads as a sub-discipline within biology. In other countries where a more traditional ruling scientific orthodoxy holds sway, ID is a target of scientific censorship.

It is a well-known adage, “Where there's smoke, there's fire.” There is certainly a lot of smoke surrounding this ID-versus-natural-selection controversy. This book gives us the clearest picture yet of the fire, and thereby takes the science of ID one step closer to validation as a rigorous and scientifically robust explanation for the immense information-richness of life.

— **Andrew Ruys**, Professor of Biomedical Engineering (Retired), University of Sydney

*The Design Inference, 2nd Edition*, is a much needed (and much appreciated) update to Bill Dembski's classic work, this time co-authored with Winston Ewert. In the twenty-five years since the first edition, the work has been strengthened and substantially

extended, and in the process the ideas have been made more accessible to less technical audiences. Among its many other benefits, this work provides a solid foundation for future research into the exquisite and astounding design of living systems.

— **Steve Laufmann**, enterprise systems architect, Program Chair of the Conference on Engineering in Living Systems (CELS), leader of Discovery Institute’s Engineering Research Group (ERG), and co-author with Howard Glicksman of *Your Designed Body*

The first edition of *The Design Inference*, published by Cambridge University Press, was welcomed with academic accolades because in many disciplines we need a robust capacity to rule out chance, and Dembski’s design-inferential method confers that capacity. But when it was realized that this method, based on sound statistical and information-theoretic concepts, may trigger a design inference once applied to biological complexity, the storm clouds gathered. It is not that Dembski’s design inference was discredited, but rather that, for many, the rule of naturalism must remain absolute.

In this expanded second edition we are shown how the design inference makes design part of the very fabric of science. Dembski and Ewert make a strong case for regarding specified complexity as the key to design detection and as a normal tool for everyday inquiry. They carefully define specification and complexity mathematically and illustrate these concepts with helpful examples. Given the solid theoretic foundation for design inferences provided here, researchers will be better equipped to answer whether biology is solely the domain of unguided processes or instead reveals the activity of a designing mind.

— **Mark Fitzmaurice**, MD, Sydney, Australia

Mathematical probabilists like myself happily work deductively with axioms proposed by A. N. Kolmogorov some ninety years ago. By and large we leave to statisticians the daunting task of combining probability theory with inductive evidence. And I don’t know that even statisticians tend to be eager to ply their trade on the controversial, ultimate questions of existence. It is natural that



the lot of us would feel convicted by Pascal’s rebuke, “Those who do not love the truth take as a pretext that it is disputed, and that a multitude deny it.”

Dembski and Ewert, on the other hand, don’t shy away from discussing the evidence for a designing intelligence, framing their arguments in a systematic and general way. In *The Design Inference* they write clearly and irenically, which makes the book a pleasure to read. I believe their work is worthy of attention and respect.

— **Christopher P. Grant**, Associate Professor of Mathematics,  
Brigham Young University

This second edition is many things—humble conceptual remodeling, quarter-century labor of love, and testament to true intellectual partnership. Dembski and Ewert remind us of something we already know: debate drowns in shallow water and thrives in logical depth. Layperson and expert alike are encouraged to explore the endnotes and remarkable appendices. The authors leave no stone unturned, and neither should the reader.

— **Tristan Abbey**, President, Comarus Analytics LLC

In his book, *Six Great Ideas*, the philosopher Mortimer Adler stated: “There would be stars and atoms in the physical cosmos with no human beings or other living organisms to perceive them. But there would be no ideas as objects of thought without minds to think about them.”

Stars and atoms are the venue of physics. During the last century, the vast majority of physicists have made peace with the notion that the universe had a beginning, and that any attempt to assign a cause or mechanism or prior state to that beginning lies beyond the reach of the natural sciences.

Darwinists, however, persist in the hubris of believing that they have fully resolved how the chance assemblage of an exponentially lengthy sequence of statistically impossible events could produce life in all its variations. Any objections to this conclusion are met with censorship, derision, and a profound obliviousness to the mathematical hurdles confronting the Darwinian view. We have

sadly reached an anti-scientific point in many circles where even openly thinking about an alternative explanation is viewed as heresy.

In this second edition of *The Design Inference*, Dembski and Ewert present a formidable probabilistic and information-theoretic method for determining whether design, rather than chance, was the cause of an observed event. They then apply this method to the intricate forms we find in biology. With devastating mathematical precision, the book demonstrates that any complex event having both a briefly described specification and a small probability of occurrence—that is, small in light of all available probabilistic resources—must logically be attributed to design rather than chance.

This edition also incorporates further mathematical refinements, particularly in the account of *specified complexity*. It updates many of the references. And it convincingly refutes the various objections raised since the publication of the original version.

It is remarkable that the question of design, ubiquitous in everyday experience, is met with such ferocious resistance when it comes to thinking about the origin of living organisms, which represent the ultimate in specified complexity. Minds open to the issues raised in this book will be able to fruitfully engage the debate over biological origins. In this greatly revised and expanded edition, opponents of design have a new and unenviable challenge to surmount.

— **Terry Rickard**, PhD, Engineering Physics, University of California, San Diego

The first edition of *The Design Inference* in 1998 cemented the validity of ID as the first bona fide challenge to natural evolution, whose foundational tenets had stood largely unchanged, and whose position in biology was not seriously threatened for over a hundred years. In this second edition, authors Dembski and Ewert provide even more incontrovertible evidence that luck has its limits, and the devil is truly in the details. Meanwhile, the Darwinists still have no

effective counterarguments save that their blind watchmaker did indeed manage to make the watch you wear.

— **Kenneth Poppe**, EdD, Southern Nazarene University,  
professor and author of books on educational reform

Rare are the truly original, landmark books that have deeply impacted both science and the philosophy of science. For biology, one such work was Charles Darwin's *Origin of Species* (1859), whose thesis was that the design features of the biological world are mere illusion. Another was Jacques Monod's *Chance and Necessity* (1970), which reduced life to Darwin's natural selection and chance variations interpreted as the blind ruthlessness of the laws of nature working on the blind randomness of genetic mutations.

But in 1998, just when we thought the last nail had been driven into the coffin of intelligent goal-directedness in the natural world, Dembski's epochal, paradigm-shifting *The Design Inference* shook the foundations of materialistic reductionism, giving new vigor to a seemingly moribund teleology. Consequently, a reanimated *teleological realism* is now a great poker hand to hold in an intellectual wager where a designing mind appears to have stacked the deck in its favour.

*The Design Inference* launched the intelligent design movement as a truly novel *scientific* theory within natural philosophy and placed it on a solid intellectual footing with its notion of specified complexity. Dembski and Ewert's 25th-anniversary edition adds many new silvery pearls to the intellectual necklace of the first. This book applies to all areas of science. But for biology, and especially for "organs of extreme perfection" like the eye, it implies that after 160 years, "Darwin's dangerous idea" has met its match in "Dembski's pivotal postulate."

— **Marc Mullie**, MD, Ophthalmologist, Montreal, Canada

It is increasingly understood that the random-mutation selection mechanism is a woefully inadequate explanation for the origin and development of all of life. Probability arguments strongly support the conclusion that a random search algorithm (which the Neo-

Darwinian mutation/selection mechanism is) on the space of possible arrangements of nucleotides, amino acids, saccharides and glycerols is far too limited to invent or discover genetic codes, molecular machines and metabolic networks, to name a few.

But the unresolved question is if a design hypothesis can be given credence.

Sometimes, but not always, artists put their signature on a work of art. But signature or not, there are usually telltale signs that identify the object as having been designed. In the language of Bill Dembski and Winston Ewert, these are that the object or event has very low probability of occurring “naturally” and has evidence of being specified. It is these two characteristics that Dembski identifies as a design filter, and in this book, a revision of Dembski’s groundbreaking, but controversial, *The Design Inference*, he gives a more precise definition of what these terms mean. With this amplification and clarification, significant steps have been taken to better quantify the likelihood that something is designed. Since it uses probabilistic arguments, there can be no rigorous mathematical proof that life is designed. But in my opinion, in no small part informed by Dembski’s arguments, it would take a truly foolish person to bet against it.

I highly recommend you give this book a serious read.

— **James P. Keener**, Distinguished Professor of Mathematics,  
University of Utah



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# FOREWORD

IN 1998 PHILOSOPHER AND MATHEMATICIAN WILLIAM DEMBSKI published a book with Cambridge University Press that would forever change the debate about design and purpose in biology. *The Design Inference: Eliminating Chance Through Small Probabilities* provided a powerful conceptual framework for understanding the origin of complexity and purpose in living things. The second edition of this seminal work, co-authored with software engineer Winston Ewert, is a profound and long-awaited reflection on the design inference and its relevance to biological complexity, specification, and information.

For millennia, philosophers and scientists ascribed biological complexity and purpose to design. In the age of theistic faith, the awe-inspiring purposefulness and complexity of living things seemed as convincing an argument for divine providence as could be imagined. With the publication in 1859 of Darwin's *Origin of Species*, and the accompanying tsunami of atheist ideology, a new age of atheistic faith inundated the scientific world. It seemed that biological design could be explained away by invoking Darwinian random heritable variation and natural selection.

In his book *The Blind Watchmaker*, Richard Dawkins famously summed up the Darwinian perspective. "Biology," he admitted, "is the study of complicated things that give the appearance of having been designed for a purpose."<sup>1</sup> But, he quickly added, any such appearance of design is illusory: "Natural selection is the blind watchmaker, blind because it does not see ahead, does not plan consequences, has no purpose in view. Yet the living results of

natural selection overwhelmingly impress us with the appearance of design as if by a master watchmaker, impress us with the illusion of design and planning.”<sup>2</sup> Because all biological design is thereby explained away, Dawkins concluded, “Darwin made it possible to be an intellectually fulfilled atheist.”<sup>3</sup>

Of course, even after Darwin, perceptive scientists continued to point out that the complexity and purpose evident in living things still left atheists a bit short of intellectual fulfillment. Darwinian faith was *de rigueur* in the twentieth century, and this despite the discovery of a computer code in DNA and astonishingly elegant molecular nanotechnology in living things, including cellular organelles like the bacterial flagellum that work according to obvious engineering principles.<sup>4</sup> Nonetheless, it took a brave soul to dare question the Darwinian paradigm in biology. Those scientists who did question atheist dogma tended to become unfulfilled in the sense of “unemployed.”

For a few scientists, truth mattered more than sinecure. Yet the scientific truth was hard to come by. The problem was that the mountains of evidence both for and against Darwinian theory were largely mountains of anecdotes. Darwinists pointed to anecdotal hunches that an imagined sequence of variation and selection could produce the genetic code, the beating heart, and even the brain by which an improbably evolved species of apes could ask such questions. Design scientists pointed to functional biological complexity that seemed beyond what even the most fanciful Darwinian stories could account for—think of the camera eye, which gave even Darwin sleepless nights.<sup>5</sup>

What was needed to settle the issue was not merely a rehash of the conflicting anecdotes for and against design, but a conceptual framework on which to organize and probe this trove of disparate evidence. What was needed was a *scientific theory* of design detection—a theory that could detect its presence, confirm its absence, and was falsifiable and thus testable by observation and experiment. This was a big ask. The reason it was so difficult to make the design question a genuinely scientific question is that a cogent theory of design—a method by which to detect its presence and confirm its absence—requires deep understanding of biology

and mathematics, and a subtle and clear understanding of the treacherous philosophical terrain on which any scientist probing design in biology must walk. Particularly necessary was skill with the philosophy and mathematics of probability theory, which is an indispensable part of the process of testing the design inference. Few thinkers, no matter how astute and how motivated, had the diligence and resources to apply such insight to the study of living things.

Bill Dembski, fortunately, did. The brilliance of Dembski's work is that it provides a rubric—the Explanatory Filter—by which design can be confidently inferred. The Filter can be applied to a host of scientific inquiries—forensic science, origin-of-life research, SETI, cryptography, and archeology, among many others. It provides mathematical and logical rigor to an enduring human intuition that design can be inferred in nature. The Explanatory Filter, and the conceptual framework that undergirds it, describes a quantitative method, which by eliminating chance and necessity infers design. In particular, design becomes detectable by identifying a specifiable pattern in a highly improbable event. Although *The Design Inference* does not invoke Aristotle, its method of design detection, when applied to biology, dovetails nicely with Aristotle's definition of life as substance that seeks intrinsic goals.<sup>6</sup>

This second edition of *The Design Inference* is a fascinating in-depth exploration of the scientific and mathematical issues Dembski introduced twenty-five years ago. The authors carefully explain the conceptual development of the Explanatory Filter and its theoretical underpinning, specified complexity. Though they view biology as the ultimate proving ground for the design inference, they also show its applicability to a wide variety of human endeavors. They even discuss “bad” design, a topic frequently raised by Darwinists to undermine the design inference.<sup>7</sup>

Dembski's and Ewert's discussion in the epilogue on conservation of information, a topic not developed in the first edition, is enthralling. They make the profound observation that biological *processes*, and not simply biological *products*, can exhibit design. Just as the design inference is an analytic tool for

products such as biomolecules, conservation of information is an analytic tool for the processes that originate biological products.

Biology is not merely the study of the structure of living things; it is the study of the biological processes that build, orchestrate, and transmit life, including the evolutionary process itself. And as mind-boggling as the structure of the DNA double helix and the intricate anatomy of the brain and camera eye are, the processes by which these components of living things arise and function and integrate with other living components are, in my view, even more fascinating and deeply beautiful. In this second edition of *The Design Inference*, the authors devote a few pages to conservation of information as a framework for the study of biological processes. The topic is so important, however, that it warrants a separate book, which they report is forthcoming.

The design inference provides two fundamental insights for scientific research that are quite different: a theoretical design inference and a methodological design inference. The theoretical design inference uses the tools of probability, information, and complexity theory. It infers design in nature via objective quantitative methods. Its ability to detect design by means of these tools has great scientific, philosophical, and theological salience. The methodological design inference, by contrast, is a heuristic method. It assumes design for the fruitful insights that this assumption is likely to yield. It provides a powerful tool to guide scientific research, independent of its theoretical implications. In my own experience, both the theoretical and the methodological design inference have been very important.

I converted from agnosticism (atheism, really, on my bad days) to Christianity about twenty years ago. I have always loved science, but I have long suspected that the Darwinian explanation for the marvelous workings of living things fell short of reality and very short of good science. Even in high school, I noticed that while physics, chemistry, and general biology were solid sciences, evolutionary biology seemed to be a collection of dogmatic just-so stories. My suspicions were affirmed in college when, as a biochemistry major, I was very uncomfortable with the inference that intricate molecular pathways arose without planning or design.

How did the Krebs cycle or DNA transcription and translation happen without intelligent agency? The Darwinian explanation—that such elegant molecular arrangements were merely the consequence of hundreds of millions of years of (biotic or prebiotic) natural selection—struck me as implausible in the extreme. And I noticed that my professors of biochemistry and evolutionary biology were always short on specifics—they couldn't account quantitatively for a single molecular structure or pathway using Darwinian mechanisms. I was told, implicitly, to take it by faith. If I believed, I would come to understand. So, through college and medical school I stuck with Darwinian explanations. I assumed that my doubts were the result of my ignorance of Darwinian theory, and when I understood evolution well enough, it would all make sense.

My conversion to Christianity is a complex story, but the design inference and the intelligent design movement played a big role. I came to see that my doubts about Darwinian explanations were well founded—my doubts were in fact based on good and rigorous science. Reading and understanding *The Design Inference* helped me to clearly see the evidence for God's unmistakable creativity and wisdom in living things. I was also deeply impressed by Dembski's application of rigorous mathematics to the question of design. It mirrors, I believe, the landmark work of computer scientist Judea Pearl in the development of causal analysis.<sup>8</sup> The design inference is the application of probability and information theory to the detection of purpose in living things. Like Pearl's groundbreaking work, Dembski's research provides us with the opportunity to move beyond mere statistical correlation and to detect causation and design in nature. What an exciting and powerful approach to biological science!

But the importance of the design inference goes well beyond theoretical science. The design inference is also heuristic—a powerful tool for biological research as well as a landmark in theoretical biology. Of course, the inference to design has been the cornerstone of biological science since Aristotle. Scientists take a living thing apart, just as engineers would take apart a manufactured device of unknown provenance, to understand the design

principles by which it was made and by which it works. Biological research is quite literally the reverse-engineering of living things. Nothing in biology really makes sense without the inference to design.

The fundamental questions a biologist must ask include the following: What is the purpose of this structure? What does it accomplish in the organism? Why is it designed in this way and not another? Traditionally, these questions were framed within a broader theological question, namely, Why did God make it that way? Nowadays, in the shadow of the atheism that constrains modern science, scientists are careful to hide their design inferences (if they wish to remain employed). They generally infer design implicitly, not explicitly. But the design inference is *always* there, for the atheist as well as the theist. Imagine doing research on the heart without acknowledging that it is a pump, or on DNA without admitting that it contains a code, or on ribosomes or mitochondria without knowing they are protein factories or power plants inside cells.

I am a pediatric neurosurgeon and a research professor at Stony Brook University, and the design inference has been essential to my own research. One of the most common disorders I treat is hydrocephalus, which is the accumulation of cerebrospinal fluid in the brain. It afflicts millions of children and adults, and often threatens life. I have known for many years that our traditional understanding of its cause is woefully inadequate, and I have worked for twenty years to better understand it. For a century, neurosurgeons have believed that hydrocephalus is caused by a blockage of the cerebrospinal fluid absorption sites in the brain (e.g., due to infections or hemorrhage or congenital deformities), but many of us in the hydrocephalus research community knew that this understanding of the disease was inadequate.<sup>9</sup> The cornerstone of our new approach to understanding hydrocephalus was the work of Dan Greitz, a neuroscientist in Stockholm who used MRI studies to show that hydrocephalus is intimately connected to abnormalities of the way the brain pulses in response to the arterial pulse from the heart.<sup>10</sup>

Following on Greitz's research, we noted two remarkable things about the coupling of the heart pulse and the brain pulse.<sup>11</sup>

First, the brain selectively suppresses the energy of the arterial pulse around the frequency of the heartbeat, thereby protecting the delicate brain capillaries from damage due to the high energy of the heartbeat. This phenomenon has been found in other organs of the body and is called the *windkessel effect*. Second, we found that the brain pulse *precedes* the heartbeat by about 150 milliseconds—that is, the pulse in the brain happens *before* the pulse from the heart reaches the brain, which supposedly causes it! Clearly, a new understanding of intracranial dynamics was needed.<sup>12</sup> I searched the physiological literature for an explanation of these findings. There was none—in fact, previous medical researchers weren't even aware of these remarkable characteristics of the pulse in the brain.

To understand the dynamics of the arterial pulse and the windkessel effect in the brain, I applied the Explanatory Filter from the design inference. These characteristics of the brain pulse were clearly not due to a regularity or necessity, because in nature the selective suppression of forced vibrations does not regularly occur at the frequency of the forcing pulse (it can occur at any frequency naturally) and the timing of the vibrations varies considerably. The characteristics of the brain pulse were certainly not due to chance, because the finding of frequency-specific suppression and phase lead of the brain pulse is quite consistent across all experiments and is found in all animals and humans.<sup>13</sup> It is also unimaginably improbable that chance mutations, whether or not coupled to natural selection, could have engineered such an exquisite system in the step-by-functional-step process required of natural selection, creating a functional brain pulse in a common ancestor of the various living forms that possess it. So that left us with one explanation—the pulsatile dynamics in the brain are designed.

For me, as for others, that inference was not the end of the investigative process, but the beginning. I turned to the study of design, which is engineering. I bought every engineering book I could find on harmonic motion and vibration suppression. I studied how human designers build systems to suppress pulses in machines, in electrical circuits and in pipes carrying water and gas. I learned that there was a design for vibration suppression called a

band stop filter that specifically suppresses frequencies near the fundamental frequency of the harmonic force causing the vibration (i.e., the heart rate), just as we had found happens in the cerebral windkessel mechanism.

Together with my engineering colleagues at Stony Brook University, we simulated the windkessel effect that we measured in a series of experimental dogs on a simple band stop filter electrical circuit.<sup>14</sup> The voltage in the circuit corresponded to the pressure in the brain, the current in the circuit corresponded to the motion of fluids and tissues, and the charge in the circuit corresponded to the displacement of intracranial fluids and tissues. The output of the circuit was almost identical to the pressure tracings from the brain. A simple electrical circuit designed according to data from pulsatility in the brain simulated the dynamics of the pulse in the brain with remarkable accuracy. Both systems—the designed circuit and the pulsing brain—worked on the same dynamic principles.

We carefully studied the dynamics of the simple circuit and came to understand how the windkessel effect in the brain worked—the rhythmic expansion and relaxation of the brain suppressed the arterial pulse in a manner analogous to the rhythmic loading and unloading of the capacitor in the electrical circuit. This shed light on hydrocephalus, which we now understand as a disorder of the cerebral windkessel mechanism caused by excessively high resistance in the pulsatile motion (the pulsating “current”) of cerebrospinal fluid in and around the brain.

Furthermore, our design-based research provided an answer to the perplexing observation that the pulse in the brain *precedes* the arterial pulse entering the brain by about 150 milliseconds. In a steady-state oscillating system hampered by appreciable resistance to harmonic motion (which is certainly the case with the brain), the optimal pulsation suppression occurs when the mass of the pulse is increased, which results in a leading phase between the pulse that is being suppressed (the brain pulse) and the forcing pulse (the arterial pulse). Our design-based research explained the perplexing lead of the brain pulse with respect to the arterial pulse—it optimizes the windkessel mechanism in order to protect brain



capillaries. The cerebral windkessel mechanism is not merely designed. When functioning normally it is *optimally* designed and carefully tuned!

Our design research is ongoing, but the design inference is transforming our understanding of blood and cerebrospinal fluid flow in the brain and providing novel insights into treatment of disorders such as hydrocephalus, stroke, and brain trauma. Our work has been predicated on the reverse engineering of intracranial dynamics—all of which is based on the design inference.

This book, *The Design Inference*, is ideologically neutral. Its design inferential logic is a tool for research, not an assertion of faith. It confers scientific rigor on the inescapable everyday intuition that we can discern design in many of the designed objects around us. This logic can provide compelling evidence for design and, as an impartial arbiter, it can be used to raise legitimate doubts in cases where someone may have erroneously ascribed design. It is as relevant to the Darwinist as to the design scientist. Both intelligent design theory and Darwinian theory key off of the design inference, as opposite sides of the same coin.

Oddly, the Darwinian reaction to the design inference has not been analytic. It has been allergic. The quest for the truth about design in biology seems to be the farthest thing from the Darwinian mind. This book's generous gift of a scientific methodology that could convincingly confirm or disconfirm Darwinian theory has been met by Darwinists not by relief and gratitude but by evasion and contemptuous silence punctuated occasionally by outright malice.<sup>15</sup> Some of the explanation for this unscientific response is undoubtedly the challenging mathematics inherent to the detection of specified complexity and the discomfort evolutionary biologists understandably feel over the quantitative analysis of their own claims. Much of the Darwinian opposition to the design inference is ideological.

What is needed in biology is a willingness by biologists to subject Darwinian evolutionary claims to objective quantitative testing. The time for "mountains" of anecdotes has passed. In this superb new edition of *The Design Inference*, Dembski and Ewert set design science on a solid scientific foundation and provide

scientists with the opportunity to test their theories for and against design using objective quantitative methods. It's hard to escape the conclusion that the Darwinists' striking refusal to engage this work thoughtfully and honestly is motivated by the strength, not the weakness, of the challenge the design inference poses to modern evolutionary theory.

Only by applying the design inference will biologists be able to decisively confirm their theories about the origin of biological complexity, specification, and information. The risk, of course, is that doing so will instead disconfirm them. But such are the hazards of any scientific enterprise, whose primary concern must always be the rigorous pursuit of truth. Full scientific rigor in the biological sciences requires the logic of the design inference as laid out in this book.

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