THE SOUL OF SCIENCE:

Christian Faith and Natural Philosophy

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Science, philosophy, even theology, are, all of them, legitimately interested in questions about the nature of space, structure of matter, patterns of action and, last but not least, about the nature, structure, and value of human thinking and of human science. Thus it is that science, philosophy, and theology, represented as often as not by the very same men—Kepler and Newton, Descartes and Leibniz—join and take part in the great debate.

—Alexandre Koyre

From the Closed World to the Infinite Universe
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ACKNOWLEDGMENTS

We are grateful to the Fieldstead Institute for a grant that enabled us to devote time to this project. Special thanks likewise to Marvin Olasky, series editor, for his excellent suggestions and his patience in shepherding the book over rocky terrain. We also want to express our appreciation to Byron Borger, owner of Hearts and Minds bookstore, who tenaciously hunted down books needed for research and alerted us to important new works as they came out.

We would like to thank the following people for giving generously of their time to review various parts of the manuscript in draft form: Jeff Boersema, Robert Brabenec, Gene Chase, Roy Clouser, Frederick Gregory, Christopher Kaiser, David Lindberg, Donald McNally, Steve Meyer, J. P. Moreland, Paul Nelson, Jim Neidhardt, Jitse van der Meer, Ted Plantinga, Robert Newman, Del Ratzsch, Kim Robbins, Karen Scantlin, David Shotton, Frederick Skiff, Paul Thigpen, Thaddeus Trenn, Peter Vibert, Jonathan Wells. We also thank J. Richard Pearcey for excellent editorial assistance.
Isaac Newton—a Christian? I never learned *that* in school.” The young woman’s jaw dropped in surprise. She had recently earned a master’s degree in an honors program at a major university. She had been a leader in Christian campus groups. Yet not once in her educational career had she learned that key figures in the history of science operated within a Christian framework, that their science was inspired and motivated by their religious convictions.

Those of us who work in the sciences may be so familiar with these historical facts that we forget how remote they are to the average Christian in the pew. The typical science textbook is narrowly designed to acquaint students with major scientific discoveries. It presents little of the scientists’ underlying philosophical or religious motivations. The sole exceptions to that rule seem to be instances when philosophical or religious beliefs were rejected—such as Copernicus’s rejection of Ptolemaic geocentric cosmology or Galileo’s rejection of Aristotelian physics. This selective textbook presentation tends to create in the student an implicitly positivist impression of science—that progress in science consists in its “emancipation” from the confining fetters of religion and metaphysics. Typically the student also assumes, at least unconsciously, that the historical characters who led this emancipation must have shared the same derogatory view of religion and philosophy.

Nothing could be further from the truth. In recent decades, the positivist view of science has been assailed for both logical difficulties and historical inaccuracies. As a result, science historians have developed a new sensitivity to the role played by extra-scientific factors in the development of modern science. Historians have broadened their interest beyond the textbook presentation, with its simple chronology of discoveries, to the scientist as a human being—to the complex of beliefs, assumptions, and socio-political forces that motivated his scientific research. The result has been a much more interesting and colorful tapestry of the past and ultimately a more accurate portrayal of the progress of science.

The new approach more readily recognizes the influence of Christianity on science. Up to the turn of the century, Christianity was the dominant intellectual force in most areas of life and culture in the West. Christians were not a marginalized minority; they were the majority. The truth is that we cannot really understand a Newton, a Descartes, or a Cuvier without delving into the religious and philosophical ideas that drove their scientific work.

We speak advisedly of both religious and philosophical ideas. For while orthodox Christians have held certain fundamental theological convictions in common, they have often differed in their understanding of how to express and apply their theology in areas such as science. Christians begin with Scripture and creation—God’s Word and God’s world. But the way we relate the two is through the intermediary of philosophy—a philosophy of nature and of God’s relationship to it, an abstract conception informed by Scripture but not uniquely determined by Scripture. Christians who share theological orthodoxy may embrace different philosophies of nature.

In this book, we will identify and track some of the more significant philosophical streams of thought since the scientific revolution. As we proceed, it will become clear that the progress of science was a far cry from the simple “emancipation” from religion. On the contrary, science has been shaped largely by debates among Christians over which philosophy of nature gives the best way to conceptualize the kind of world God created and the nature of His relationship to it. Even after philosophical materialism began to penetrate scientific thought, Christian influences remained vibrant. References to God in public discourse were common. Not until the late nineteenth to early twentieth century did Christian faith lose its hold as a shared, public commitment and retreat to the realm of private, individual belief.
Our goal in this book is to describe highlights in the growth of science both before and after this change took place. Roughly the first half of the book covers the history of science in its formative stages when Christianity was the backdrop to virtually all scientific discussion, when disagreements took place primarily among Christians over how to best express God’s relationship to the natural world. The second half of the book describes key controversies that have changed the face of science since Christianity declined as a public and communal faith—the revolution in mathematics brought on by non-Euclidean geometry, the revolution in physics triggered by relativity theory and quantum mechanics, and the revolution still taking place in biology through the discovery of DNA and the rise of molecular biology. We will outline some of the challenges these revolutions raised to a Christian understanding of nature.

In a survey book of this type, directed at a semi-popular audience, we paint necessarily with broad strokes. We can only hope we have highlighted and simplified without oversimplifying. Furthermore, our goal is to be historical and descriptive rather than analytical or polemical, which means we describe historical controversies and debates without necessarily coming down on any particular side. Finally, we do not seek to give a comprehensive treatment of the subject matter of various disciplines. Instead, we point out highlights in each field, themes and ideas that we find significant for a Christian understanding of science and its historical development.

Our main purpose in this book is to reintroduce Christians to a part of our rich intellectual heritage. Like the young woman described earlier, many Christians live on the thin edge of contemporary life with only a tenuous connection to the past. This ahistorical perspective tends to reinforce a pietistic attitude toward faith and culture. If all we know is today—and no one can deny that today Christianity is on the margins of the intellectual and cultural world—then we have no model for breaking out of that pattern.

By acquainting ourselves with forerunners in the faith, however, we discover a different model. We learn that until comparatively recent times, Christians have actively worked out the implications of their faith in all areas of life and scholarship—from philosophy to mathematics to physics to biology. Christian faith has not been a purely private matter. Nor has it been shut off in a separate part of life, as though it were relevant to worship but not to work.

In this book we introduce readers to people whose “secular” accomplishments flowed from a deep commitment to their faith, who understood that Christianity is meant to be developed into a complete worldview. May their example rekindle the same vision in us and inspire us to go and do likewise.
The most curious aspect of the scientific world we live in, says science writer Loren Eiseley, is that it exists at all. Westerners often unconsciously assume a doctrine of Inexorable Progress, as though the mere passage of time leads inevitably to increased knowledge as surely as an acorn becomes an oak. “Yet the archaeologist would be forced to tell us,” says Eiseley, “that several great civilizations have arisen and vanished without the benefit of a scientific philosophy.” The type of thinking known today as scientific, with its emphasis upon experiment and mathematical formulation, arose in one culture—Western Europe—and in no other.

Science, Eiseley concludes, is not “natural” to mankind at all. Inquisitiveness about the world is indeed a natural attitude, but institutional science is more than that. “It has rules which have to be learned, and practices and techniques which have to be transmitted from generation to generation by the formal process of education,” Eiseley notes. In short, it is “an invented cultural institution, an institution not present in all societies, and not one that may be counted upon to arise from human instinct.” Science “demands some kind of unique soil in which to flourish.” Deprived of that soil, it is “as capable of decay and death as any other human activity, such as a religion or a system of government.”

What is that unique soil? Eiseley identifies it, somewhat reluctantly, as the Christian faith. “In one of those strange permutations of which history yields occasional rare examples,” he says, “it is the Christian world which finally gave birth in a clear, articulate fashion to the experimental method of science itself.”

Eiseley is not alone in observing that the Christian faith in many ways inspired the birth of modern science. Science historians have developed a renewed respect for the Middle Ages, including a renewed respect for the Christian worldview culturally and intellectually dominant during that period. Today a wide range of scholars recognize that Christianity provided both intellectual presuppositions and moral sanction for the development of modern science.

**REHABILITATION OF THE MIDDLE AGES**

From the Enlightenment until the early twentieth century, scholars generally divided history into three stages—the ancient world, regarded as brilliant though limited in its scientific understanding; the medieval world, dismissed as a time of intellectual and cultural desolation (the “dark ages”); and the modern age, heralded as a time when reason and enlightenment
arose to dispel the mists of medieval superstition. But in recent years that simple schema has been challenged, particularly its negative characterization of the medieval period.

The rehabilitation of the Middle Ages began with the work of French physicist and philosopher Pierre Duhem (1861–1916). Searching for historical examples to illustrate his philosophy of science, Duhem investigated the history of statics (a branch of mechanics dealing with masses or forces at rest). At the outset of his research, he adopted the common assumption that the Middle Ages had contributed nothing to science. He anticipated that his story would begin with the ancient Greeks (Archimedes) and proceed directly to Leonardo da Vinci, vaulting over all intervening history.

But digging into historical sources, Duhem uncovered the work of a thirteenth-century scientist named Jordanus de Nemore, who had anticipated Leonardo and Galileo in his work on the foundations of statics. Duhem then uncovered fourteenth-century scientists such as Albert of Saxon, Jean Buridan, and Nicole Oresme, who had likewise done important work in the field. He became convinced that the roots of modern science reached back to the work of these medieval scientists—and that far from being a period of stagnation, the Middle Ages actually laid the foundations for the flowering of science.

Duhem was a Catholic, and some have dismissed his conclusions as an attempt to cast a more favorable light on the Middle Ages, dominated as it was by the Catholic church. But as historian David Lindberg argues, Duhem seems to have been genuinely surprised by the scientific fertility of the medieval mind. This is not to say, however, that he was insensitive to the religious implications of his discoveries. Duhem was quick to see apologetical value in the fact that Christianized medieval Europe was not hostile to scientific learning after all—that, on the contrary, it was the womb that gave birth to the scientific enterprise.

**Images of War**

Duhem’s work inspired other historians to probe the various ways Christianity provided an intellectual environment conducive to scientific endeavor. That such questions are even entertained indicates a dramatic turnaround in thinking about the relation between science and Christian faith. The image most of us grew up with was one of conflict and hostility. Phrases such as “the war between science and religion” are so familiar many people don’t even challenge them.

Yet this conception of warfare is actually a misconception, and one of recent lineage. Over some three centuries, the relationship between faith and science can best be described as an alliance. The scientist living between 1500 and the late 1800s inhabited a very different universe from that of the scientist living today. The earlier scientist was very likely to be a believer who did not think scientific inquiry and religious devotion incompatible. On the contrary, his motivation for studying the wonders of nature was a religious impulse to glorify the God who had created them. Indeed, though he studied the physical creation, he was unlikely to be a scientist per se (the term “scientist” was not coined until 1834) but a churchman. Especially in the English countryside, the parson-naturalist was a common figure.

As Colin Russell tells it in his book *Cross-Currents: Interactions Between Science and Faith,* the idea of a war between science and religion is a relatively recent invention—one carefully nurtured by those who hope the victor in the conflict will be science. In late nineteenth-century England, several small groups of scientists and scholars organized under the leadership of Thomas H. Huxley to overthrow the cultural dominance of Christianity—particularly the intellectual dominance of the Anglican church. Their goal was to secularize society, replacing the Christian worldview with scientific naturalism, a worldview that recognizes the existence of nature alone. Though secularists, they understood very well that they were replacing one religion by another, for they described their goal as the establishment of the “church scientific.” Huxley even referred to his scientific lectures as “lay sermons.”

It was during this period that a whole new literature emerged purporting to reveal the hostility religion has shown toward science throughout history. The most virulent were works by John William Draper (1811–1882) and Andrew Dickson White (1832–1918)—works regarded by most historians today as severely distorted because of the authors’ polemical purposes.

Draper’s *History of the Conflict Between Religion and Science* portrayed the history of science as “a narrative of the conflict of two contending powers, the expansive force of the human intellect on one side, and the compression arising from traditionary faith and human interests on the other.” The faith Draper has in mind is primarily that of the Catholic church, and he uses the language of “antagonism” and “struggle”—“a bitter, a mortal animosity.” He accuses the Catholic church of “ferociously suppressing by the stake and the sword every attempt at progress” and of having hands “steeped in blood!”

Draper’s dramatic scenario of a great battle between theologians and scientists attracted a wide readership, but its anti-Catholicism eventually dated the book. White’s *A History of the Warfare of Science with Theology* had a more lasting influence. As late as 1955, Harvard historian of science George Sarton was still praising White for writing “an instructive book.”

In 1965, in an abridged edition of White’s book, historian Bruce Mazlish praised White for establishing his thesis “beyond any reasonable doubt.” And in 1991, a well-known science writer, on hearing that we were composing a book on the history of science and Christian faith, took the time to write us and recommend White’s book as an important treatment of the subject.

White states his central thesis in these words:

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6 6. The lesson of White’s book, Sarton says, is that theologians who “were indiscreet enough to interfere” with science always ended up supporting the wrong theories. “I wonder,” Sarton muses, “whether they were not the victims of a sly devil who wanted to make fun of them.” There’s no doubt that Sarton himself was making fun of them. He goes on to praise theologians who know better than to “tamper” with scientific controversies. George Sarton, “Introductory Essay,” in *Science, Religion, and Reality,* ed. Joseph Needham (New York: George Braziller, 1955), pp. 14–15.
In all modern history, interference with science in the supposed interest of religion, no matter how conscientious such interference may have been, has resulted in the direst evils both to religion and to science.  

Heaping up quotation upon quotation, laced with heavy sarcasm and irony, White purported to prove the pernicious effects of Christianity upon the advance of science. White’s themes were picked up by several lesser writers, all telling the same story, etching into Western consciousness a mythology of fierce combat between science and Christian faith.

Even as the warfare image spread, however, it began to be challenged. Scientists and historians such as Alfred North Whitehead and Michael B. Foster became convinced that, far from impeding the progress of science, Christianity had actually encouraged it—that the Christian culture within which science arose was not a menace but a midwife to science.

**The Nature of Nature**

It should not be terribly surprising that Christianity was an important ally of the scientific enterprise. After all, modern science arose within a culture saturated with Christian faith. That historical fact alone is suggestive. It was Christianized Europe that became the birthplace of modern science—that and nowhere else.

Through sheer practical know-how and rules-of-thumb, several cultures in antiquity—from the Chinese to the Arabs—produced a higher level of learning and technology than medieval Europe did. Yet it was Christianized Europe and not these more advanced cultures that gave birth to modern science as a systematic, self-correcting discipline. The historian is bound to ask why this should be so. Why did Christianity form the matrix within which this novel approach to the natural world developed?

Of course, many factors other than Christian faith contributed to making science possible—the growth of trade and commerce, technological advances, the founding of scientific institutions such as the Royal Society, increased circulation of journals, and so on. Yet these were not so much the sources of the scientific revolution as the avenues by which it spread. The source itself seems to have been a tacit attitude toward nature, a flowering forth of assumptions whose roots had been deepening and strengthening for centuries.

Scientific investigation depends upon certain assumptions about the world—and science is impossible until those assumptions are in place. As Foster argues, Western thinkers had to ascribe to nature the character and attributes that made it a possible object of scientific study in advance of the actual establishment of science. As Whitehead puts it, “faith in the possibility of science” came antecedently to the development of actual scientific theory.

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Some historians object to the term “revolution” to describe the beginnings of modern science, since the process was neither sudden nor violent. We will use the term only in the sense that certain philosophical concepts (e.g., Aristotelian cosmology) were overthrown and replaced.

This faith, Whitehead explains, rested on certain habits of thought, such as the lawfulness of nature—which in turn, he maintains, came from the Christian doctrine of the world as a divine creation. Whitehead did not mean that everyone living in Europe at the time of the scientific revolution was a committed Christian. But even those who rejected orthodox Biblical doctrines continued to live and think within the intellectual framework of the Biblical worldview. “I am not talking of the explicit beliefs of a few individuals,” Whitehead says, but rather “the impress on the European mind arising from the unquestioned faith of centuries”—the “instinctive tone of thought and not a mere creed of words.”

What is this “tone of thought”? Christian conceptions of reality are woven so extensively into the fabric of the Western mind that it takes an effort of the historical imagination to perceive their originality. Indeed, throughout much of Western history, Christian scholars have been so receptive to external philosophical ideas—so willing to formulate their positions in terms derived from Aristotelianism or neo-Platonism (as we shall see in following chapters)—that the uniqueness of the Christian perspective was nearly obscured. Yet unique it was, and the best way to perceive its novelty is to set it alongside contrasting views common in the ancient world.

**Here Today, Here Tomorrow**

Science is the study of nature, and the possibility of science depends upon one’s attitude toward nature. Biblical religion gave to Western culture several of its fundamental assumptions about the natural world.

To begin with, the Bible teaches that nature is real. If this seems too obvious to mention, recall that many belief systems regard nature as unreal. Various forms of pantheism and idealism teach that finite, particular things are merely “appearances” of the One, the Absolute, the Infinite. Individuality and separateness are illusions. Hinduism, for instance, teaches that the everyday world of material objects is *maya*, illusion. It is doubtful whether a philosophy that so denigrates the material world would be capable of inspiring the careful attention to it that is necessary for science.

The Christian doctrine of creation, on the other hand, teaches that finite objects are not mere appearances of the Infinite. God made them; they have a real existence. In the words of Langdon Gilkey, professor of theology at the University of Chicago School of Divinity, the doctrine of creation implies that the world is not illusory; it is “a realm of definable structures and real relations, and so is a possible object both for scientific and for philosophical study.”

**God Made It Good**

Science rests not only on metaphysical convictions but also on convictions about value. A society must be persuaded that nature is of great value, and hence an object worthy of study. The ancient Greeks lacked this conviction. The ancient world often equated the material world with evil and disorder; hence, it denigrated anything to do with material things. Manual labor was relegated to slaves, while philosophers sought a life of leisure in order to pursue the “higher things.” Many historians believe this is one reason the Greeks did not develop an empirical science, which requires practical, hands-on observation and experimentation.

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Against the surrounding Greek culture, the early church defended a high view of the material world. Christianity teaches that the world has great value as God’s creation. Genesis repeats the joyful refrain again and again: “And God saw that it was good.” In the words of Mary Hesse, a British philosopher of science, “there has never been room in the Hebrew or Christian tradition for the idea that the material world is something to be escaped from, and that work in it is degrading. Material things are to be used to the glory of God and for the good of men.” As a result, “in western Europe in the Christian era there was never the same derogation of manual work. There was no slave class to do the work, and craftsmen were respected.”

The dignity of work became an even more prominent theme in the Reformation. The concept of “calling” was extended from church vocations to secular vocations. According to theologian Ian Barbour, Protestants believed that “man should serve God not by withdrawing to a monastic life but by carrying out any honest and useful job with integrity and diligence.” This general enhancement of the dignity of work, Barbour says, served to endorse scientific work as well.

John Calvin, for example, did not call merely for the devotional contemplation of creation; he also called for active labor in creation, both practically and intellectually. In Calvin’s words, “there is need of art and more exacting toil in order to investigate the motion of the stars, to determine their assigned stations, to measure their intervals, to note their properties.”

In the spirit of the Reformation, the astronomer Johannes Kepler wrote of being “called” by God to use his talents in his work as an astronomer. In one of his notebooks, Kepler broke spontaneously into prayer:

13 13. Thomas Torrance writes that the “Christian belief in the goodness and integrity of the physical universe … played an incalculable part in transforming the ancient worldview. It destroyed the Platonic and Aristotelian idea that matter is, if not evil, the raw material of corruption and unreality and the source of disorder in the universe, and it also ruled entirely out of consideration the pessimistic views of nature that emanated from the dualist sects such as the Manichaeans and Gnostics, thereby emancipating the material reality of the universe for serious scientific attention.” From Divine and Contingent Order (Oxford: Oxford University Press, 1981), p. 67.


15 15. Ian Barbour, Issues in Science and Religion (New York: Harper and Row, Harper Torchbooks, 1966), pp. 48–49. This is not to overlook the fact that the monks did engage in labor, regarding it as one way to glorify God. Nevertheless, many historians have noted the distinctive emphasis in Protestantism on the moral and spiritual value of all labor. See, for example, Max Weber in The Protestant Ethic and the Spirit of Capitalism (New York: Charles Scribner’s Sons, 1958). For Luther, Weber says (p. 81), “every legitimate calling has exactly the same worth in the sight of God.”

I give you thanks, Creator and God, that you have given me this joy in thy creation, and I rejoice in the works of your hands. See I have now completed the work to which I was called. In it I have used all the talents you have lent to my spirit.  

In the same spirit, the early chemist Jean-Baptiste van Helmont insisted that the pursuit of science is “a good gift,” given by God. This broad concept of calling lent spiritual and moral sanction to science as a legitimate way of serving God.

**A Garden, Not a God**

In Biblical teaching, nature is good, but it is not a god. It is merely a creature. The Bible stands firmly against any deification of the creation.

Pagan religions are typically animistic or pantheistic, treating the natural world either as the abode of the divine or as an emanation of God’s own essence. The most familiar form of animism holds that spirits or gods reside in nature. In the words of Harvey Cox, a Baptist theologian, pagan man “lives in an enchanted forest.” Glens and groves, rocks and streams are alive with spirits, sprites, demons. Nature teems with sun gods, river goddesses, astral deities. Totemism rests on the idea that the creatures of the natural world are tied to human beings in a bond of spiritual kinship.

The Biblical doctrine of creation rules out all this. God does not inhabit the world the way a dryad inhabits a tree; He is not the personalization of natural forces. He is not the world’s “soul”; He is its Creator. It is the work of His hands, as a vase is the work of the potter. The opening lines of Genesis 1 stand in stark contrast to most ancient religions in rejecting any religious status to the sun, moon, and stars. In Genesis the heavenly bodies are not divine; they are merely “light-bearers,” placed in the sky to serve God’s purposes, the way a woman hangs a lantern to light the porch.

Dutch historian of science R. Hooykaas describes this as the “de-deification” of nature. Natural phenomena—sun, moon, forests, rivers—are no longer seen as the locus of deity, no longer objects of religious awe and reverence. They are creations of God, placed in the world to serve His purposes and contribute to human welfare.

The de-deification of nature was a crucial precondition for science. As long as nature commands religious worship, dissecting her is judged impious. As long as the world is charged with divine beings and powers, the only appropriate response is to supplicate them or ward them off. In the words of seventeenth-century chemist Robert Boyle, the tendency to regard nature as sacred “has been a discouraging impediment” to science.

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20 20. The full quotation from Boyle, given in Klaaren p. 150, is as follows:

The veneration, wherewith men are imbued for what they call nature, has been a discouraging impediment to the empire of man over the inferior creatures of God: for many have not only looked upon it, as an impossible thing to compass, but as something *impious to attempt*, the removing of those boundaries which nature seems to have put and settled among her productions; and whilst they look upon her as such a venerable thing, some make a kind of...
Science is not merely a method of inquiry; it begins with an intellectual stance vis-a-vis the natural world. As Cox writes, “however highly developed a culture’s powers of observation, however refined its equipment for measuring, no real scientific breakthrough is possible until man can face the natural world unafraid.” The monotheism of the Bible exorcised the gods of nature, freeing humanity to enjoy and investigate it without fear. When the world was no longer an object of worship, then—and only then—could it become an object of study.

**A Rational God, an Orderly World**

To become an object of study the world must be regarded as a place where events occur in a reliable, predictable fashion. This, too, was a legacy of Christianity. Whereas paganism taught a multitude of immanent gods, Christianity taught a single transcendent Creator, whose handiwork is a unified, coherent universe.

Presbyterian theologian Thomas Derr expresses the idea in these words:

“Man did not face a world full of ambiguous and capricious gods who were alive in the objects of the natural world. He had to do with one supreme creator God whose will was steadfast. Nature was thus abruptly desacralized, stripped of many of its arbitrary, unpredictable, and doubtless terrifying aspects.”

In a similar vein, Nobel Prize-winning biochemist Melvin Calvin muses on the fundamental conviction in science that the universe is ordered:

“As I try to discern the origin of that conviction, I seem to find it in a basic notion discovered 2000 or 3000 years ago, and enunciated first in the Western world by the ancient Hebrews: namely, that the universe is governed by a single God, and is not the product of the whims of many gods, each governing his own province according to his own laws. This monotheistic view seems to be the historical foundation for modern science.”

Of course, the idea of order in nature rests not simply on the existence of a single God but also on the character of that God. The God revealed in the Bible is trustworthy and dependable; the creation of such a God must likewise be dependable. Derr explains:

“As the creation of a trustworthy God, nature exhibited regularity, dependability, and orderliness. It was intelligible and could be studied. It displayed a knowable order.”

The work of Copernicus provides a historical example. Copernicus tells us that, in his search for a better cosmology than that of Aristotle and Ptolemy, he first went back to the writings of other ancient philosophers. But he uncovered significant disagreement among the

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ancients regarding the structure of the universe. This inconsistency disturbed him, Copernicus said, for he knew the universe was “wrought for us by a supremely good and orderly Creator.” His own scientific work became a quest for a better cosmology—one that would, in the words of theologian Christopher Kaiser, “uphold the regularity, uniformity, and symmetry that befitted the work of God.”

Another historical example comes from the eighteenth century when an explosive increase in knowledge of new life forms threatened to destroy belief in an underlying order in the organic world. Zoologist Ernst Mayr describes the near-bewilderment among natural historians of the time:

When viewing the almost chaotic mountains of new species, how could one avoid asking, “Where is that harmony of nature of which every naturalist is dreaming? What are the laws that control diversity? What plan did the father of all things have when he designed little creatures and big ones?”

Yet those committed to the doctrine of creation held firmly to belief in a divine plan even in the face of apparent chaos. “It was simply inconceivable, in a period so strongly dominated by natural theology,” Mayr writes, “that organic diversity could be totally without rhyme or reason, that it could be simply the result of ‘accident.’” This dogged faith spurred naturalists on in the hope of discovering “the plan of creation.” They trusted that because God had made the world, in the end it would reveal an underlying order.

Follow the Law
Belief in an orderly universe came to be summed up in the concept of natural law. The phrase “laws of nature” is so familiar to the modern mind that we are generally unaware of its uniqueness. People in pagan cultures who see nature as alive and moved by mysterious forces are not likely to develop the conviction that all natural occurrences are lawful and intelligible.

In every culture, of course, craftsmen have developed rough-and-ready rules of procedure. But when they encounter an irregularity or anomaly, they simply accept it as part of the inscrutable nature of things. As historian A. R. Hall points out, the concept of natural law was unknown to both the ancient Western world and the Asian world. When the concept finally arose in the Middle Ages, Hall says, it signified “a notable departure” from anything that had gone before.

The source of this departure Hall identifies as the Biblical teaching of a Creator. As he puts it, the use of the word law in the context of natural events “would have been unintelligible in antiquity, whereas the Hebraic and Christian belief in a deity who was at once Creator and Law-giver rendered it valid.” The Biblical God is the Divine Legislator who governs nature by decrees set down in the beginning. We see that conviction, for example, in the writings of seventeenth-century mathematician and philosopher Rene

Descartes, who said the mathematical laws sought by science were legislated by God in the same manner as a king ordains laws in his realm.

The order of the reasoning here is important. The early scientists did not argue that the world was lawfully ordered, and therefore there must be a rational God. Instead, they argued that there was a rational God, and therefore the world must be lawfully ordered. They had greater confidence in the existence and character of God than in the lawfulness of nature.

As historian Carl Becker explains, until the scientific revolution was well under way, nature simply did not strike most people as either lawful or rational. Nature “seemed to common sense intractable, even mysterious and dangerous, at best inharmonious to man.” The deep conviction that nature is intelligible came from Biblical principles. In Becker’s words, theologians

argued that, since God is goodness and reason, his creation must somehow be, even if not evidently so to finite minds, good and reasonable. Design in nature was thus derived a priori from the character which the Creator was assumed to have.

The idea of natural law, Becker concludes, was not derived from observations; it was derived prior to observations from belief in the Biblical God. It was not a fact of experience but an article of faith.

Precisely So

One of the most distinctive aspects of modern science is its use of mathematics—the conviction not only that nature is lawful but also that those laws can be stated in precise mathematical formulas. This conviction, too, historians have traced to the Biblical teaching on creation.

The Biblical God created the universe ex nihilo and hence has absolute control over it. Genesis paints a picture of a Workman completely in charge of His materials. Hence in its essential structure the universe is precisely what God wants it to be.

This idea was alien to the ancient world. In all other religions, the creation of the world begins with some kind of pre-existing substance with its own inherent nature. As a result, the creator is not absolute and does not have the freedom to mold the world exactly as he wills.

For example, in Greek philosophy the world consists of eternal matter structured by eternal rational universals called Ideas or Forms. In Plato’s creation myth, the creator

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argues that nature is a lawful machine, and therefore God must be a rational engineer. Natural law had ceased to be an article of faith and had become identified with the observed behavior of objects. (Becker, pp. 56–57.)

In other words, whereas formerly the existence of God was regarded as so certain that it could serve as the starting point for argument, now it was the orderliness of nature, discovered by science, that was regarded as more certain. Order in nature became the starting point of argument, and the existence of God became an inference from it. This is not to deny the importance or validity of design arguments but only to point out the massive intellectual shift that has taken place.

28. Carl Becker, The Heavenly City of the Eighteenth-Century Philosophers (New Haven: Yale University Press, 1932), p. 55. By the eighteenth century, however, the logic of the argument began to be reversed, taking on the form familiar to us today. As science progressively revealed the marvelous order of nature, people began to argue not from God to order but from order to God. This is the classic argument from design.

For example, in Hume’s Dialogues Concerning Natural Religion, the character Cleanthes does not argue that God is eternal reason, and therefore nature must be rational; instead he argues that nature is a lawful machine, and therefore God must be a rational engineer. Natural law had ceased to be an article of faith and had become identified with the observed behavior of objects. (Becker, pp. 56–57.)
(demiurge) is an inferior deity who did not create from nothing; he merely injected reason (Ideas) into reason-less matter. And even that he did imperfectly because matter was stubborn stuff, capable of resisting the rational structure imparted by the Ideas. In short, this is a creator whose hands are tied, as Hooykaas writes, in two respects:

He had to follow not his own design but the model of the eternal Ideas; and second, he had to put the stamp of the Ideas on a chaotic, recalcitrant matter which he had not created himself.\(^\text{29}\)

As a result, the Greeks expected a level of imprecision in nature, a certain fuzziness at the edges. If some facts did not fit their theories, well, that was to be expected in an imperfect world. Individual things were, after all, only rough approximations to the rational Ideas or Forms. As historian Dudley Shapere explains, in Greek thought the physical world “contains an essentially irrational element: nothing in it can be described \textit{exactly} by reason, and in particular by mathematical concepts and laws.”\(^\text{30}\)

By contrast, the Christian doctrine of creation \textit{ex nihilo} means there is no pre-existing substance with its own independent properties to limit what God can do. God creates the world exactly as He wills. For a Platonist, if a line in nature is not quite circular, that is because nature is an only partially successful approximation to geometrical Ideas. But for a Christian, if God had wanted the line to be circular, He would have made it that way. If it is not exactly a circle, it must be exactly something else—perhaps an ellipse. The scientist can be confident that it is exactly \textit{something}, and not mere capricious variation from the ideal.

A striking example can be found in the work of Kepler, who struggled for years with the slight difference of eight minutes between observation and calculation of the orbit of the planet Mars. Eventually this slight imprecision drove him to abandon the idea of circular orbits and to postulate elliptical orbits. If Kepler had not maintained the conviction that nature must be precise, he would not have agonized over those eight minutes and would not have broken through a traditional belief in circular orbits that had held sway for two thousand years. Kepler spoke gratefully of those eight minutes as a “gift of God.” Thus the application of geometry and mathematics to the analysis of physical motion rests on the Christian doctrine of creation \textit{ex nihilo}. The implication is that God is omnipotent; there is no recalcitrant matter to resist His will. In the words of physicist C. F. von Weizsacker:

\begin{quote}
Matter in the Platonic sense, which must be ‘prevailed upon’ by reason, will not obey mathematical laws exactly: matter which God has created from nothing may well strictly follow the rules which its Creator has laid down for it. In this sense I called modern science a legacy, I might even have said a child, of Christianity.\(^\text{31}\)
\end{quote}


\(^{31}\) C. F. von Weizsacker, \textit{The Relevance of Science} (New York: Harper and Row, 1964), p. 163. See also George Herbert Mead, \textit{Movements of Thought in the Nineteenth Century}, Works of George Herbert Mead, vol. 2, ed. and intro. Merritt H. Moore (Chicago: University of Chicago Press), pp. 1, 5–8. Mead writes that science rests on the “confident faith” that every detail in nature can be rationally understood. The source of that faith, he says, is the theological doctrine that the world was created by a God who was infinitely intelligent and who had infinite power. Everything that such a deity created … must be the expression of that intelligence, and nothing could resist its expression…. There could be nothing accidental or irrational in such a world.
Historian R. G. Collingwood expresses the argument most succinctly. He writes: “The possibility of an applied mathematics is an expression, in terms of natural science, of the Christian belief that nature is the creation of an omnipotent God.”

The Spitting Image
Belief in a rational order in nature would have no practical benefit for science were it not accompanied by the belief that humans can discover that order. Historically, Eiseley says, science stemmed from “the sheer act of faith that the universe possessed order and could be interpreted by rational minds.” The latter is just as important as the former. It signifies that science cannot proceed without an epistemology, or theory of knowledge, guaranteeing that the human mind is equipped to gain genuine knowledge of the world. Historically, this guarantee came from the doctrine that humanity was created in the image of God.

A cross-cultural comparison can help clarify the point. Joseph Needham, a student of Chinese culture, asks in his book The Grand Titration why the Chinese never developed modern science. The reason, he said, is that the Chinese had no belief either in an intelligible order in nature nor in the human ability to decode an order should it exist. As Needham writes:

There was no confidence that the code of Nature’s laws could be unveiled and read, because there was no assurance that a divine being, even more rational than ourselves, had ever formulated such a code capable of being read.

The Chinese did sense some order in nature, but they conceived of it as an inherent necessity inscrutable to the human mind. “It was not an order ordained by a rational personal being,” Needham explains, “and hence there was no guarantee that other rational personal beings would be able to spell out in their own earthly languages the pre-existing divine code of laws which he had previously formulated.”

In Europe, by contrast, there was such a “guarantee”—namely, belief that a rational Creator made both the world and also “rational personal beings.” The implication is that the two kinds of rationality—divine and human—are in some measure similar. As a result, humans can “think God’s thoughts after Him.” As Kaiser explains, it is because humans reflect the same rationality by which God ordered creation that they can understand that order. Stated briefly, the natural world is comprehensible because “the same Logos that is responsible for its ordering is also reflected in human reason.”

To speak of the rationality of creation is not to deny the Biblical teaching of the Fall, which states that since the original creation the world has been marred by sin, death, and disharmony. Yet the Fall does not completely destroy the inherent character of creation. It represents a temporary disfigurement of that character—a disfigurement that can be reversed in redemption. This is quite different from the Greek view where matter is intrinsically opposed to reason, order, and goodness.

35 35. Kaiser, Creation and the History of Science, pp. 10, 121. Similarly, historian Robert Cohen notes that the rise of science required a belief in a “rational creator of all things,” with its corollary that “we lesser rational beings might, by virtue of that Godlike rationality, be able to decipher the laws of nature.” Robert Cohen, “Alternative Interpretations of the History of
We find historical evidence for this confidence in human reason in a study of science and religion in Elizabethan England by historian Paul Kocher. During that period, Kocher says, people generally believed that natural science was a gift of God to humanity. This was not taken to mean that science had been implanted ready-made in the human mind; rather God had created humans with the powers of observation and reasoning necessary to gain reliable knowledge about the natural world. Confidence in human reason was tempered by the doctrine of the Fall, which taught that the human intellect is marred by sin and open to error and distortion. In the main, however, Christian faith undergirded the conviction that humans had been given the capacity to know truth. In Kocher’s words, the theory of knowledge tacitly accepted by Elizabethan scientists “rested on the faith that God, having placed man here on earth, could not have been so wasteful or so ironic as to blind him to the real nature of the surrounding world.”

**Look and See**

To say that the order of creation can be grasped by human intelligence is to say that it is intelligible. Yet there may be differing ideas of what kind of order and what kind of intelligibility the world exhibits. Throughout Western history, various conceptions of intelligibility have vied for acceptance.

Consider first the Aristotelian concept of intelligibility. Aristotelian logic understood natural objects on the model of man-made artifacts. An artifact like a chair or a saucepan can be analyzed as a material substratum arranged according to the guiding principle of a rational goal or purpose (the Aristotelian Form). Indeed, what defines the object is not the material base but the purpose. It does not matter, for example, whether a saucepan is made of aluminum or cast iron, just so long as it is an object in which liquids may be heated.

Moreover, once we understand the purpose of the saucepan, we may then deduce by rigorous logic many of its properties—that its shape must be such that it can contain liquid, that it must not melt when heated, that it must not dissolve in certain liquids, and so on. In Aristotelian logic, these properties belong to its essence or Form.

The same logic was applied to nature. For the Aristotelian, nature consists of matter structured by purposes, essences, Forms. The scientist best understands a natural object by asking what it is for. Once the purpose of the object has been uncovered, in Aristotle’s view, the scientist knows all that is really necessary. He has penetrated to the heart of reality. He does not need to make detailed observations of the object because, with its purpose in mind, he can deduce what its essential properties must be, just as we deduced the properties of a saucepan.

This pattern of reasoning was taken from geometry. Once we know that a triangle is a three-sided figure, we can deduce many of its other properties. Thus Aristotelian science tended to stress rational intuition of purposes or Forms followed by deduction, rather than observation and experiment.

In the thirteenth century, Thomas Aquinas adapted Aristotelian philosophy to Christian belief in a hybrid system of thought that came to be called scholasticism. The scholastics

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reinterpreted the Forms as God’s purposes in nature, injected by God at creation. In the Christianized version, the Forms became created powers that act as God’s lieutenants or vice-regents to order nature. As a result, science continued to emphasize rational intuition of the Forms rather than experimentation. Experimental science had to await a shift away from Aristotelianism.

The shift began when some Christians became troubled by the Aristotelian concept of Forms. The concept appeared to limit God’s creative activity, as though God had to make do with the prescribed properties of matter. For example, some Christian Aristotelians argued that the “nature” of the heavens demanded circular motion by its inner law of rational necessity—as though God’s hand were restrained by some inherent necessity in the structure of things.

In 1277 Etienne Tempier, Bishop of Paris, issued a condemnation of several theses derived from Aristotelianism—that God could not allow any form of planetary motion other than circular, that He could not make a vacuum, and many more. The condemnation of 1277 helped inspire a form of theology known as voluntarism, which admitted no limitations on God’s power. It regarded natural law not as Forms inherent within nature but as divine commands imposed from outside nature. Voluntarism insisted that the structure of the universe—indeed, its very existence—is not rationally necessary but is contingent upon the free and transcendent will of God.

Voluntarist theology eventually inspired the Reformers who emphasized the passive impotence of sinners in salvation and the freedom and sovereignty of God. As Gary Deason shows, these theological ideas eventually trickled over into science. The view of sinners as passive inspired a parallel view of matter as passive. Matter was driven not by internal rational Forms but by the sovereign commands of God. The freedom of God in bestowing salvation inspired a parallel view of His freedom in creation and providence. God was not restricted by any inherent necessity; He freely bestowed order according to His own will and design.

As historian A. C. Crombie explains, the problem with Christian Aristotelianism was that it viewed the universe as “a necessarily determined emanation from God’s reason, instead of a free creation of His will, as Christian theology taught.” In its extreme form, Aristotelianism held

that the ultimate rational causes of things in God’s mind could be discovered by the human reason; and that Aristotle had in fact discovered those causes, so that the universe must necessarily be constituted as he had described it, and could not be otherwise.

It was this notion of necessity constraining even God Himself that the voluntarists objected to. In contrast, they emphasized God’s omnipotence and His freedom to create the world according to His own purposes, by His sovereign commands.

As a historical example, consider van Helmont, an early chemist. Van Helmont was adamantly opposed to the Aristotelian concept of final cause, and equated natural law with divine command. He wrote:

I believe that Nature is the command of God, whereby a thing is that which it is, and doth that which it is commanded to do or act.

This, he wrote, is “a Christian definition, taken out of the Holy Scripture,” as opposed to an Aristotelian definition. 40 In fact, van Helmont’s intense opposition to Aristotle won him an appearance before the Spanish Inquisition and a stint in prison.

Robert Boyle echoed the themes of voluntarist theology as well, referring to God as the “free establisher of the laws of motion” and noting that these laws “depend perfectly on his will.” He spoke of God’s creatures as “the limited and arbitrary productions of his power and will,” formed not by any independent rational agency within creation but by “God’s immediate fiat.” 41

Isaac Newton’s commitment to voluntarism is evident in the following quotation from an unpublished manuscript: “The world might have been otherwise than it is (because there may be worlds otherwise framed than this). Twas therefore noe necessary but a voluntary & free determination yt should bee thus.” 42

One of the most important consequences of voluntarist theology for science is that it helped to inspire and justify an experimental methodology. For if God created freely rather than by logical necessity, then we cannot gain knowledge of it by logical deduction (which traces necessary connections). Instead, we have to go out and look, to observe and experiment. As Barbour puts it:

The world is orderly and dependable because God is trustworthy and not capricious; but the details of the world must be found by observation rather than rational deduction because God is free and did not have to create any particular kind of universe. 43

For example, Aristotle had argued that the earth must be at the center of the cosmos because it is “natural” for the heaviest element to gravitate towards the geometric center. In other words, he appealed to an innate tendency in matter. Copernicus, on the other hand, argued that there can be many centers of gravity because gravity is “bestowed on the parts of bodies by the Creator”—and obviously the Creator can bestow such powers wherever He chooses. As Kaiser explains, for Copernicus “the laws of nature are not intrinsic and cannot be deduced a priori: rather they are imposed or infused by God” and can only be known a posteriori, through empirical investigation.

The clearest statement of the connection between voluntarist theology and experimental method is in Roger Cotes’s Preface to the second edition of Newton’s Principia. Cotes argued that the world “could arise from nothing but the perfectly free will of God directing and presiding over all.” In all of creation, Cotes wrote, there is “not the least shadow” of logical

41 41. A thorough discussion of Boyle can be found in Klaaren, Religious Origins of Modern Science, from which these quotations were taken (pp. 135, 139, 151).
44 44. Kaiser, Creation and the History of Science, p. 110, emphasis added. Similarly, Marin Mersenne (1588–1648) criticized Kepler’s early attempts to force the solar system into a geometrical pattern—his argument being that it is wrong to cherish any preconceived pattern for the structure of the solar system since it is only one of infinitely numerous possibilities and therefore ultimately dependent on the choice of the deity. See John Hedley Brooke, Science and Religion: Some Historical Perspectives (Cambridge: Cambridge University Press, 1991), p. 26.
necessity—and “therefore,” he concluded, we must learn “from observations and experiments.”

We see that the conviction that the world is contingent—its order imposed rather than inherent—provided a powerful justification for the experimental method of science. As historian John Hedley Brooke puts it, “If the workings of nature reflected the free agency of a divine will, then the only way to uncover them was by empirical investigation. No armchair science, premised on how God must have organized things, was permissible.”

Science must observe and experiment.

Not Our Ways

The idea that the creation is contingent is sometimes taken to mean it is chaotic and unpredictable. But in its Christian form, contingency does not mean that at all. The goal of voluntarist theology was to emphasize that God is not bound by anything outside Himself; He is, however, bound by His own nature. As theologian Thomas Torrance writes, “The contingency of the creation as it derives from God is inseparably bound up with its orderliness, for it is the product not merely of his almighty will but of his eternal reason.”

The world does not have its own inherent rationality, but it is intelligible because it reflects God’s rationality. Yet because it is God’s rationality we are talking about and not our own, we cannot always anticipate how it will reveal itself in creation. As theologian John Baillie puts it, “While everything in nature observes a rational pattern, and is therefore in principle intelligible by us, we cannot know in advance which rational pattern it is going to follow.”


46 46. Brooke, *Science and Religion*, pp. 139–40, emphasis in original. This interpretation of the condemnation of 1277, as fostering experimental methodology in science, was first advanced by Pierre Duhem. It can also be found in Foster and Hooykaas. Yet we need to be cautious about drawing a direct causal connection. Historian David Lindberg argues that the immediate effect of the condemnation was to throw a tighter theological rein around the neck of philosophical inquiry. See *The Beginnings of Western Science* (Chicago: University of Chicago Press, 1992), pp. 234–44.

Edward Grant maintains that the condemnation contributed initially to skepticism by eroding confidence in the capacity of human reason to arrive at demonstrated truth, whether in theology or in natural philosophy. For if there are no necessary rational connections in creation, how can reason penetrate its structure? See “Science and Theology in the Middle Ages,” *God and Nature*, pp. 54–58. It took centuries before science came to be defined as a process not of deducing necessary connections but of describing contingent regularities.


In science that means we cannot merely intuit what seems reasonable. Instead, we must observe how nature operates. We must look and see.

The implication again is that science must be experimental. A prime historical example is Galileo. He did not follow the typical method of inquiry in his day and ask whether it was “reasonable” to suppose that a ten-pound weight would fall to the ground more quickly than a one-pound weight, based on the “nature” of weight. Instead, he dropped two balls from the leaning tower of Pisa and watched what happened. We cannot presume to know how God thinks, Galileo argued; we must go out and look at the world He created.49

Roger Cotes gives this argument its clearest expression. “He who is presumptuous enough to think that he can find the true principles of physics and the laws of natural things by the force alone of his own mind, and the internal light of his reason,” Cotes wrote, must suppose “that himself, a miserable reptile, can tell what is fittest to be done.” These words are taken from the same passage quoted above where Cotes recommends that instead of relying on “the internal light” of our own reason, we ought to rely on observation and experiment. Hence the Christian conviction that God’s ways are not our ways was another powerful inspiration in the new experimental approach to science.

The Glory of God and the Benefit of Mankind

Modern science has given birth to modern technology, as we all know. Yet the transition from science to technology itself required certain presuppositions about the world. It required a set of beliefs that sanctioned active intervention in natural processes to advance human purposes.

In animism and pantheism, the divine is immanent in the universe, whether conceived as several deities inhabiting the woods and rivers or as a single spirit permeating all things. The universe is the sole all-encompassing reality.

In this context, the individual is an expression of nature, incapable of transcending his environment. The intellectual stance vis-a-vis nature is passive. The human mind is thoroughly embedded in nature; it does not transcend it as subject over against object. As a consequence, humans are interested in knowing nature only in order to adapt and conform to it, not in order to harness its forces for practical ends.

By contrast, the Biblical view begins with a transcendent God and with the creation of humanity in His image. Humans find their essential kinship not with nature—as expressed in totems and idols—but with God. The human mind is thus capable of transcending nature and confronting it as subject. In this context, the individual is active vis-a-vis nature. Humans do not merely conform to nature but are free to manipulate it, both theoretically in mathematical formulas and practically by experiment.50 In this way, Christianity provided both an intellectual framework and a motive for developing technology. Borrowing a favorite phrase of the early scientists, the goal of science was the glory of God and the benefit of mankind.

Christians found Biblical justification for an active use of nature in the creation account (Genesis 1:28), where God gives human beings “dominion” over the earth. Dominion was understood not as license to exploit nature ruthlessly but as responsibility to cultivate it, care for it, and harness its forces for human benefit.

49 49. Some historians have argued that the story of Galileo and the leaning tower of Pisa is apocryphal, or that it was merely a “thought experiment” carried out theoretically. Other historians are more inclined to accept the story as genuine. Either way the point still stands: Galileo argued explicitly that we cannot rationally intuit the ways God created objects to behave; instead, we must observe their actual behavior.

In Genesis we also learn that God brought the animals to Adam to be named (2:19–20). It was idiomatic in Hebrew that to name something is to assert mastery over it; hence this account gives additional sanction for human dominion over nature. It was also idiomatic in Hebrew that a name should express the essential nature of a thing. Hence naming the animals required careful investigation to determine what sort of things they were—a task involving detailed observation, description, and classification. Thus Genesis appeared to give divine justification to the study and analysis of the natural world. Science came to be understood as one aspect of the “cultural mandate,” the Christian duty to investigate and develop the powers of creation through human culture. John Cotton, a Puritan divine who emigrated to America, wrote in 1654 that “to study the nature and course and use of all God’s works is a duty imposed by God.”

That modern science owes something to the Christian notion of duty was first suggested by sociologist R. K. Merton in the 1930s. Since that time, several critics have assailed the so-called “Merton thesis,” many arguing that his focus was overly narrow. (He treated primarily Puritanism.) Nevertheless, as science historian P. M. Rattansi argues, it is now generally accepted that the Christian concept of moral obligation played an important role in attracting people to the study of nature. It was by necessity a strong attraction, since at the time scientific study had to be carried on “outside the traditional framework of higher education and, indeed, [had] to oppose the natural philosophy taught at the universities.” Hence the enduring truth in the Merton thesis, Rattansi argues, is that the Christian religion provided “a powerful religious motive” for engaging in experimental science. In his words, Protestant principles encouraged a commitment to the study of God’s “Book of Nature” as complementing the study of the book of God’s word. They imposed a religious obligation to make such study serve the twin ends of glorifying God and benefiting fellow-men.

The second part of that phrase—“benefiting fellow-men”—justified not only science but also technology. The early scientists regarded technology as a means of alleviating the destructive effects of the curse recorded in Genesis 3. As Francis Bacon (1561–1626) expressed it, man “fell at the same time from his state of innocency and from his dominion over creation.” Yet, “both of these losses can, even in this life, be in some part repaired; the former by religion and faith, the latter by arts and sciences.” As humans used the sciences to restore their dominion over creation, they could alleviate the suffering imposed by the Fall.

Thus science was permeated with religious concern for the poor and the sick, with humanitarian efforts to alleviate toil and tedium. As historian Lynn White explains, the “spiritual egalitarianism” of Biblical religion “ascribes infinite worth to even the lowliest of human beings as potentially children of God”—a conviction that bore fruit in humanitarian efforts to raise them up from their lowly estate. Biblical faith thus engendered “a religious

urge to substitute a power machine for a man where the required motion is so severe and monotonous that it seems unworthy of a child of God.”

The very idea that the conditions of human life could be ameliorated was itself revolutionary—and was rooted in Biblical doctrine. As Cox points out, the idea of improving one’s life cannot occur to people trapped in a cyclic, fatalistic, or deterministic view of history. But the Biblical view of history is linear, open to divine activity. In the course of time, God can create something genuinely new. So can human beings, who are made in His image. Both God and humans are first causes who can set in motion a new chain of secondary causes. Thus the Biblical view of history inspired the use of science and technology to improve the human condition.

It might be helpful to summarize this chapter so far by using John Hedley Brooke’s taxonomy of the ways Christianity has influenced the development of science. To begin with, Christian teachings have served as presuppositions for the scientific enterprise (e.g., the conviction that nature is lawful was inferred from its creation by a rational God). Second, Christian teachings have sanctioned science (e.g., science was justified as a means of alleviating toil and suffering). Third, Christian teachings supplied motives for pursuing science (e.g., to show the glory and wisdom of the Creator). And fourth, Christianity played a role in regulating scientific methodology (e.g., voluntarist theology was invoked to justify an empirical approach in science).

Among professional historians the image of warfare between faith and science has shattered. Replacing it is a widespread recognition of Christianity’s positive contributions to modern science.

CONTROVERSIES BETWEEN CHURCH AND SCIENCE
Tell the proverbial man on the street that Christianity exerted a positive influence on the rise of modern science, and you are likely to elicit astonishment and disbelief. The new appreciation for religion has not filtered down from the academy to popular culture—or to the church pew. When we told Christian friends that we were writing a book on the contributions of Christianity to science, the typical response was skepticism. To counter that skepticism, we need to debunk some common misconceptions.

Anti-religious polemics have often exaggerated the church’s opposition to science. For example, Andrew Dickson White offers the sweeping statement that “all branches of the Protestant Church—Lutheran, Calvinist, Anglican—vied with each other in denouncing the Copernican doctrine as contrary to Scripture.” But the reality is that the Reformers largely ignored the Copernican controversy, apart from a few scattered remarks recorded from a table talk by Martin Luther and a sermon by John Calvin. And even these are historically questionable. In the case of Luther, the table talks were not recorded until several years later, culled from the memory of participants. Some historians doubt whether Luther actually made the disparaging comment about Copernicus attributed to him.

56 Brooke, Science and Religion, pp. 19–33. Brooke also mentions a fifth way Christianity has influenced science—by playing a constitutive role in theory formation (e.g., Ray and Linnaeus invoked the language of Genesis 1 in their definitions of species). This will be discussed in chapter 5.
57 White, A History of the Warfare, 1:126.
In the case of Calvin, White tells us Calvin took the lead in opposing Copernicanism, citing Psalm 93:1 (“The world is firmly established, it cannot be moved”) and then asking, “Who will venture to place the authority of Copernicus above that of the Holy Spirit?” But historians point out that Calvin said no such thing and never attacked Copernicus in any way in print.\(^{58}\)

The truth is that theologians had little reason to concern themselves with Copernicanism. Modern historians often write as though Copernican theory represented a grave threat to the Christian view of human significance. Copernicus demoted mankind, it is said, from his exalted place on the center stage of the universe. For example, in *The Making of the Modern Mind* historian John Herman Randall writes that the Copernican revolution “swept man out of his proud position as the central figure and end of the universe, and made him a tiny speck on a third-rate planet revolving about a tenth-rate sun drifting in an endless cosmic ocean.” \(^{59}\)

The implication is that Christians mobilized against Copernicanism to resist this shattering of their cozy cosmology. But the literature of the day does little to support this portrayal. It is true that medieval cosmology, adapted from Aristotelian philosophy, placed the earth at the center of the universe. But in medieval cosmology the center of the universe was not a place of special significance. Quite the contrary, it was the locus of evil. At the very center of the universe was Hell, then the earth, then (moving outward from the center) the progressively nobler spheres of the heavens.

In this scheme of things, humanity’s central location was no compliment, nor was its loss a demotion. In fact, in Copernicus’s own day a common objection to his theory was that it elevated mankind *above* his true station.\(^{60}\) In medieval cosmology, human significance was rooted not in the earth’s central location but in the regard God shows toward it. Hence the idea that Copernican theory threatened the Christian teaching of human significance is an anachronism. It reads back into history the *angst* of our own age.

**The Galileo Controversy**

Christian support for the scientific enterprise is revealed more clearly when we draw a distinction between the church and individual believers. Several of the early scientists were at odds with ecclesiastical politics while holding fervently to personal religious beliefs.

The textbook case of religious persecution is the story of Galileo. The standard account was told in Jacob Bronowski’s popular television series the “Ascent of Man,” which portrayed Galileo before the Inquisition as a simple confrontation between good and evil. But historian Martin Rudwick\(^{61}\) condemns the television series as an example of “scientific

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Arthur O. Lovejoy notes that modern writers often speak as though medieval cosmology, by assigning mankind the central place in the universe, gave “man a high sense of his own importance and dignity.” But in fact the opposite is true. “For the medieval mind … the centre of the world was not a position of honor; it was rather the place farthest removed from the Empyrean, the bottom of the creation, to which its dregs and baser elements sank…. The geocentric cosmography served rather for man’s humiliation than for his exaltation.”


triumphalism” unworthy of a scientist of Bronowski’s stature. Bronowski’s treatment of Galileo’s trial was a “travesty,” Rudwick says, that could result only from a deliberate choice “to ignore the historical research” available.

The historical research Rudwick refers to is a body of evidence showing that considerably more was involved than a simple confrontation between science and religion. Giorgio de Santillana, whose book *The Crime of Galileo* is widely considered the best modern account, argues that the Galileo affair was not a confrontation between “the scientist” and a religious credo at all. Ironically “the major part of the Church intellectuals were on the side of Galileo,” de Santillana notes, “while the clearest opposition to him came from secular ideas” (i.e., from the academic philosophers). Even the Pope who ordered Galileo’s return to Rome, in chains if necessary, to answer charges before the Inquisition had once been one of the “Galileisti” (Galileo’s circle of followers).

The truth is that, on the whole, the Catholic church had no argument with Galileo’s theories as science. Their objection had to do with Galileo’s attack on Aristotelian philosophy—and all the metaphysical, spiritual, and social consequences they associated with it. As philosopher of science Philipp Frank explains, the reason Galileo’s attack on Aristotle was treated so seriously was that to many people at the time Aristotle’s philosophy was “regarded as necessary for the formulation of religious and moral laws.”

Aristotle viewed each object as a quasi-organic entity propelled by an inner striving to fulfill its ideal nature—its purpose or Form—just as human beings are motivated by a sense of moral obligation to fulfill their highest nature. In Aristotelian philosophy, objects are moved by inherent tendencies more akin to moral striving than to push-pull mechanical forces.

One of those inner tendencies was an impulse toward a “natural place” in the universe. In Aristotelian physics, a flame goes up and a rock falls down because every object has a tendency to strive for its “natural place.” Physical place was, moreover, associated with degrees of nobility (the center of the universe being the lowliest and the higher realms being the noblest). Thus the physical hierarchy studied by science reflected social and political hierarchies; the order in the physical world was related to the order in human society.

The reason some churchmen resisted giving up Aristotelian physics and cosmology was because these were intimately tied to an overall vision of moral and social life. If that tie were broken, they feared morality itself would be destroyed. Hence Galileo seemed to promote doctrines that were not only wrong but dangerous.

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64 64. It was for precisely the same reason that many Christians opposed Darwin’s theory of evolution centuries later. Long after Aristotelianism had lost credibility in physics, it remained strong in biology. Darwin’s completely materialistic account of life finally broke the Aristotelian connection between physical order and moral order. Adam Sedgwick (1785–1873), Darwin’s former teacher, saw exactly what was happening and wrote to him saying,

‘Tis the crown and glory of organic science that it *does*, through final cause, link material to moral…. You have ignored this link; and, if I do not mistake your meaning, you have done your best in one or two pregnant cases to break it.
Moreover, these new and dangerous ideas were put forward, as Mary Hesse points out, “dogmatically without sufficient evidence to support them” at the time. (Not until Newton was heliocentrism given a physical mechanism.) And when the evidence available at the time does not support a theory, resistance is neither unscientific nor irrational. Hesse concludes:

…for all their shortsightedness, the representatives of the Church had some reason on their side; theirs were the reactions of men who found, as they thought, the whole structure of their world being threatened by irresponsible speculations which did not at that time even have an adequate body of evidence in their support. 65

A full understanding of the confrontation between Galileo and the Roman church, suggests philosopher of science Jerome Ravetz, 66 must take account of sociological factors as well. The Catholic hierarchy had recently reaffirmed its commitment to Aristotelianism in response to the challenge posed by Protestantism. Hence, Galileo’s attack on Aristotle could be interpreted as giving ammunition to the enemy. In addition, a lively struggle was taking place between an older elite in the universities and churches and the newer, more pragmatically oriented elite to which Galileo belonged. Galileo’s decision to publish his works in the vernacular was a deliberate affront to the established elites, part of a broad strategy to transfer intellectual leadership to the wider reading public. 67

In the course of the debate, both sides stooped to ugly tactics. The church used nasty methods and personal spite in a campaign to cut Galileo down to size. Galileo fought back with deliberately provocative and propagandistic writings. His parable Dialogue Concerning the Two Principal Systems of the World includes a dim-witted buffoon named Simplicio, a thinly disguised caricature of the Pope who had once been Galileo’s friend and follower. 68

In spite of all this, Galileo never repudiated his faith. The typical retelling of the controversy suggests that since Galileo stood up to the church, he must have been a closet atheist or at least an agnostic. But to be true to history, we must take seriously Galileo’s own protestations that he was a genuine Christian believer who had no intention of questioning religious doctrine per se but only the scientific framework inherited from Aristotelian philosophy.

The positivist approach dismisses Galileo’s religious defense of his ideas as mere expediency, forced on him by the authorities. But Galileo’s behavior cannot be understood unless we accept his own claim that he was a believer and that he placed religion alongside science as a source of genuine information about the world. “Only Galileo’s determination to remain within his religious tradition,” writes Rudwick, “seems an adequate explanation of why he tried so hard to persuade everyone from the Pope downwards, and why he declined all chances to escape to the safety of the Venetian republic.” 69

Sedgwick went on the predict that if the link between the material and the moral order were ever broken (which he did not believe could happen), the human race would be morally brutalized and degraded. Cited in Charles Coulston Gillispie in The Edge of Objectivity (Princeton, NJ: Princeton University Press, 1960), p. 350, emphasis in original.

68 68. Russell, Cross-Currents, p. 44.
69 69. Rudwick, in The Sciences and Theology, pp. 256–57. Brooke (Science and Religion, pp. 98–99) conjectures that the “fateful urgency” with which Galileo sought to convert the
Children of Their Time

Let us be the first to acknowledge that Christians have often opposed new ideas in science. But let us also point out that this is not some perverse failing of religious people but a universal human tendency. All people tend to resist new ideas. Nor is that necessarily a failing. After all, as long as an idea remains new, its supporters generally have not yet mustered the necessary evidence for it.

As a case in point, critics often castigate the Reformers for not accepting Copernican cosmology—ignoring the fact that at the time the culture as a whole did not yet accept Copernicus. The Reformers were not being churlishly anti-intellectual; they were merely reflecting what were generally considered to be well-founded beliefs in their time. As John Dillenberger notes, “The classical Reformation figures, including Luther, Calvin, and Melanchthon, belong to the period in which there was no compelling reason for accepting the Copernican system.” In short, the Reformers were geocentric for exactly the same reason that later Protestants were Newtonian and then Einsteinian—namely, that they accepted the scientific theories current in their day.

Altering fundamental concepts about the world is never an easy process. Scientific concepts that appear obvious to moderns because we have been taught them since we were young—concepts such as heliocentricity, elliptical orbits, the circulation of the blood—were exceedingly difficult to hit upon originally. As historian Mark Graubard comments, if the solution to a scientific problem takes generations or even centuries to arrive at, and possibly just as long to become widely accepted, “then it seems more intelligent to believe that the solution is difficult, rather than to blame Aristotle, authoritarianism, human stupidity, vested interests, the Church, or any other scapegoat, for the delay.”

If Christian belief were truly a barrier to science, it is difficult to explain why so many founders of modern science were believers. Paracelsus, Boyle, and Newton wrote extensively on theology as well as on science. Others—Kepler and van Helmont—filled their scientific notebooks with prayers, praise, and theological musings.

A common device among historians has been to dismiss these theological interests as irritating distractions from purely scientific work. Yet this reaction is shortsighted, for the religious interest often provided the motivation for the scientific work. Many of the early scientists studied creation in an effort to know the Creator. Later, when religious skepticism was on the rise, many scientists hoped to use scientific discoveries to buttress religious belief. Newton wanted his work used for apologetics, as we shall see in later chapters. Mersenne and Descartes, Rattansi points out, “were actively concerned to furnish new weapons to defend religion at a time when the old arguments seemed to have been discredited.” Descartes is

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Catholic hierarchy to Copernicanism may have reflected a genuine desire to uphold the reputation of Catholic scholarship, to spare it the ignominy of holding a faulty cosmology.  

70 70. John Dillenberger, Protestant Thought and Natural Science (Notre Dame: University of Notre Dame Press, 1960), p. 29. If we truly want to understand the Reformers (and not merely castigate them), Dillenberger says, we must look at their generally positive views of science and not merely their reactions to individual theories. 


best remembered for his method of radical doubt; we generally forget that his purpose in doubting everything was to clear the way for a more substantial support for faith. To omit or dismiss these religious motivations is to misunderstand the true nature of science.

**Whither Science?**

As we conclude this chapter, we cannot avoid a haunting question: If science received much of its impetus from Christian assumptions, what will happen now that those assumptions have eroded—now that Christianity is no longer a public faith undergirding science but merely a private belief held by individual scientists? What will happen to science as the Christian motivation and intellectual scaffolding wither away? Contemporary science still lives off the accumulated capital of centuries of Christian faith. But how long will that capital last? And what will take its place?

“The experimental method succeeded beyond men’s wildest dreams,” notes Eiseley, “but the faith that brought it into being owes something to the Christian conception of the nature of God.” Belief in a trustworthy, rational God led to the assumption of an ordered, rational universe. “And science today,” says Eiseley, is still “sustained by that assumption.” The question is: How long will that assumption continue to sustain science?

It may turn out that science is detachable from the Biblical presuppositions and motivations that sustained its initial development. Science may prove itself to be self-sustaining, driven by sheer intellectual curiosity and technological success.

Yet, once separated from the teaching of divine creation, science has no philosophical ground for its most basic assumption—the lawfulness of nature. “Since the time of Hume,” Whitehead says, “fashionable scientific philosophy has been such as to deny the rationality of science.” Hume demonstrated that pure empiricism gives no grounds for belief in even such fundamental principles as cause and effect. As a result, Whitehead concludes, scientists today maintain a “scientific faith” in the order of nature while lacking any rational basis for it. And without a rational basis, it is an open question whether that “scientific faith” can long survive.

**TWO**

**The History of Science and the Science of History: Contemporary Approaches and Their Intellectual Roots**

In 1964 Frances Yates published a book that dramatically changed the study of science history. She brought into the hallowed domain of science a whole host of things previously shunned as unworthy of serious attention—mysticism, magic, religion. Titled *Giordano Bruno and the Hermetic Tradition*, Yates’s book argued that the Renaissance philosopher Bruno (1548–1600), often portrayed as a martyr for the sake of science, was in reality no such thing. Instead, he was a magus who traveled across Europe preaching a pagan gospel rooted in mystical hermetic texts.

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Bruno was, it is true, an early advocate of Copernican astronomy—hence his standard portrayal as a hero of science. He is frequently treated as a representative of rationality, a ray of truth in a dogma-darkened world. For example, in *The Making of the Modern Mind*, historian John Herman Randall describes Bruno as “the great martyr of the new science … a man whose soul was set on fire by the Copernican discoveries.”

But this stirring picture ignores most of what Bruno actually wrote and said. His soul, it turns out, was set on fire less by Copernicanism than by pagan religion. He regarded himself as a missionary for the hermetic tradition, a movement based on the writing of Hermes Trismegistus, erroneously thought to be an Egyptian sage from the time of Moses. The hermetic writings frequently treat the sun as a god, and the rest of the universe as moving and hence alive. This, it turns out, was the real reason Bruno was attracted to Copernicus’s heliocentrism. The divinity of the sun seemed compatible with an astronomy that granted it an honored position at the center of the planetary system.

Although Bruno also had some acquaintance with the scientific and mathematical basis of Copernican theory, it was not on those grounds that he defended the theory but rather on religious grounds. In the words of historian Hugh Kearney, “Bruno transformed a mathematical synthesis into a religious doctrine.” Eventually, in the Inquisition Bruno was burned at the stake—not because he courageously promulgated a better scientific theory, as is often maintained, but because he claimed to offer a better religion. He argued that the Egyptian pantheism described in the hermetic writings was superior to Christianity.

Bruno was not the only thinker of his generation to plumb ancient mystical texts for inspiration. Renaissance thinkers often sought wisdom from the ancients, which they hoped to present as an alternative to Aristotle’s philosophy, then the ruling orthodoxy in theology, philosophy, and science. Among the alternatives that emerged was neo-Platonism, a mystical philosophy from the third century that made extensive use of the hermetic writings. Bruno participated in this broader revival of neo-Platonism.

The new interpretation of Bruno as a neo-Platonic mystic did not come easily to Frances Yates. Originally, she says, she had simply intended to make an English translation of one of Bruno’s writings “with an introduction emphasizing the boldness with which this advanced philosopher of the Renaissance accepted the Copernican theory.” Yet as she read his works, Yates was puzzled by a sense that what really concerned Bruno was not Copernicanism per se but something else. So thoroughly was she primed by the standard historical interpretation that it took several years of study to recognize that the interpretative key to Bruno’s thought was hermeticism.

By treating seriously the philosophical and religious context of the historical debate over heliocentrism, Yates helped spur a new trend among science historians. She was among the first to suggest that mysticism had exerted a positive impact on the origin of the scientific outlook and was therefore a proper object of study for the historian. The Yates thesis, as it came to be called, did not merely hold that science had emerged from a world permeated with magic and mysticism; that was already widely known. Her novel interpretation was that mysticism produced a frame of mind that actually fostered the rise of modern science.

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For scientists who are people of faith, like Kenneth R. Miller, a biologist at Brown University, asking about the science of the soul is pointless, in a way, because it is not a subject science can address. "It is not physical and investigateable in the world of science," he said. "Everything we know about the biological sciences says that life is a phenomenon of physics and chemistry, and therefore the notion of some sort of spirit to animate it and give the flesh a life really doesn't fit with modern science," said Dr. Miller, a Roman Catholic whose book, *Finding Darwin's God* (Harper, 1999)
Welcome to Science of the Soul—Our goal is to aid in the merging of science and spirituality. The Soul of Science provides a thorough review of early scientific thought and the basis for it, both theologically and philosophically. Further into the book the material gets quite deep. Quantum mechanics is not easy reading and yet this book did an excellent job of providing a rudimentary understanding of the topic so the reader was able to understand the historic and philosophical impact of this development in science. This book is written by Christians and they don't hide that fact, at the same time it is a very well reasoned and winsome approach to the topic. The first section of this book deals with the supposed “war” between scientific thought and religion, and building a new history of science that shows a more subtle interplay between the two major systems of thought. Science of the Soul Study Center is a registered charitable Society. Its main objective is to promote a sense of brotherhood and communal harmony by conducting research into the world’s spiritual literature. The Society's aim is to help eradicate bias, prejudice, and ill-will by revealing humanity’s common spiritual heritage. The Society undertakes the dissemination of these principles through the distribution and sale of books. Our booklist continues to grow with new publications added periodically. BOOKS FROM THIS WEBSITE CANNOT BE SHIPPED TO INDIA For book orders within India please see