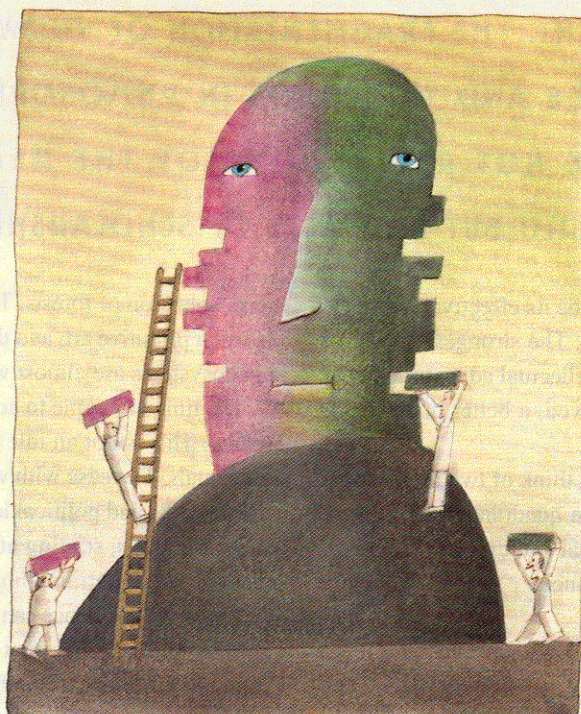


# BACK FROM CHAOS

by EDWARD O. WILSON



*Enlightenment thinkers knew a lot about everything, today's specialists know a lot about a little, and postmodernists doubt that we can know anything at all. One of the century's most important scientists argues, against fashion, that we can know what we need to know, and that we will discover underlying all forms of knowledge a fundamental unity*

**I**N contrast to widespread opinion, I believe that the Enlightenment thinkers of the seventeenth and eighteenth centuries got it mostly right. The assumptions they made about a lawful material world, the intrinsic unity of knowledge, and the potential for indefinite human progress are the ones we still take most readily to heart, suffer without, and find maximally rewarding as we learn more and more about the circumstances of our lives. The greatest enterprise of the mind always has been and always will be the attempt to link the sciences and the humanities. The ongoing fragmentation of knowledge and the resulting chaos in philosophy are not reflections of the real world but artifacts of scholarship.

The key to unification is consilience. I prefer this word to "coherence," because its rarity has preserved its precision, whereas "coherence" has several possible meanings. William Whewell, in his 1840 synthesis *The Philosophy of the Inductive Sciences*, was the first to speak of consilience—literally a "jumping together" of knowledge as a result of the linking of facts and fact-based theory across disciplines to create a common groundwork of explanation. He wrote, "The Consilience of Inductions takes place when an Induction, obtained from one class of facts, coincides with an Induction, obtained from another different class. This Consilience is a test of the truth of the Theory in which it occurs."



Consilience can be established or refuted only by methods developed in the natural sciences—in an effort, I hasten to add, not led by scientists, or frozen in mathematical abstraction, but consistent with the habits of thought that have worked so well in exploring the material universe.

The belief in the possibility of consilience beyond science and across the great branches of learning is a metaphysical world view, and a minority one at that, shared by only a few scientists and philosophers. Consilience cannot be proved with logic from first principles or grounded in any definitive set of empirical tests, at least not any yet conceived. Its best support is no more than an extrapolation from the consistent past success of the natural sciences. Its surest test will be its effectiveness in the social sciences and the humanities. The strongest appeal of consilience is in the prospect of intellectual adventure and, if even only modest success is achieved, a better understanding of the human condition.

To illustrate the claim just made, think of two intersecting perpendicular lines, and picture the quadrants thus created. Label one quadrant “environmental policy,” one “ethics,” one “biology,” and one “social science.”

environmental policy	social science
ethics	biology

We already think of these four domains as closely connected, so rational inquiry in one informs reasoning in the other three. Yet each undeniably stands apart in the contemporary academic mind. Each has its own practitioners, language, modes of analysis, and standards of validation. The result is confusion—and confusion was correctly identified by Francis Bacon, four centuries ago, as the direst of errors, which “occurs wherever argument or inference passes from one world of experience to another.”

Next imagine a series of concentric circles around the point of intersection.

environmental policy	social science
ethics	biology

As we cross the circles inward toward the point at which the quadrants meet, we find ourselves in an increasingly unstable and disorienting region. The ring closest to the intersection, where most real-world problems exist, is the one in which fundamental analysis is most needed. Yet virtually no maps exist; few concepts and words serve to guide us. Only

in imagination can we travel clockwise from the recognition of environmental problems and the need for soundly based policy to the selection of solutions based on moral reasoning to the biological foundations of that reasoning to a grasp of social institutions as the products of biology, environment, and history—and thence back to environmental policy.

Consider this example. Governments everywhere are at a loss regarding the best policy for regulating the dwindling forest reserves of the world. Few ethical guidelines have been established from which agreement might be reached, and those are based on an insufficient knowledge of ecology. Even if adequate scientific knowledge were available, we would have little basis for the long-term valuation of forests. The economics of sustainable yield is still a primitive art, and the psychological benefits of natural ecosystems are almost wholly unexplored.

The time has come to achieve the tour of such domains in reality. This is not an idle exercise for the delectation of intellectuals. The ease with which the educated public, not just intellectuals and political leaders, can think around these and similar circuits, starting at any point and moving in any direction, will determine how wisely public policy is chosen.

To ask if consilience can be gained in the domains of the innermost circles, such that sound judgment will flow easily from one discipline to another, is equivalent to asking whether, in the gathering of disciplines, specialists can ever reach agreement on a common body of abstract principles and evidential proof. I think they can. Trust in consilience is the foundation of the natural sciences. For the material world, at least, the momentum is overwhelmingly toward conceptual unity. Disciplinary boundaries within the natural sciences are disappearing, in favor of shifting hybrid disciplines in which consilience is implicit. They reach across many levels of complexity, from chemical physics and physical chemistry to molecular genetics, chemical ecology, and ecological genetics. None of the new specialties is considered more than a focus of research. Each is an industry of fresh ideas and advancing technology.

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## TERROR AND

## THE ENLIGHTENMENT

THE dream of intellectual unity was a product of the Enlightenment, an Icarian flight of the mind that spanned the seventeenth and eighteenth centuries. A vision of secular knowledge in the service of human rights and human progress, it was the West's greatest contribution to civilization. It launched the modern era for the



whole world; we are all its legatees. Then—astonishingly—it failed.

Given the prospect of renewed convergence of the disciplines, it is of surpassing importance to understand both the essential nature of the Enlightenment and the weaknesses that brought it down. Both can be said to have been embodied in the life of the Marquis de Condorcet. No single event better marks the end of the Enlightenment than his death, on March 29, 1794. The circumstances were exquisitely ironic. Condorcet has been called the prophet of the Laws of Progress. By virtue of his towering intellect and visionary political leadership, he seemed destined to emerge from the French Revolution as the Jefferson of France. But in late 1793 and early 1794, as he was composing the ultimate Enlightenment blueprint, *Sketch for a Historical Picture of the Progress of the Human Mind*, he was instead a fugitive from the law, liable to a sentence of death by representatives of the cause he had so faithfully served. His crime was political: He was perceived to be a Girondist, a member of a faction found too moderate—too reasonable—by the radical Jacobins. Worse, he had criticized the constitution drawn up by the Jacobin-dominated National Convention. He died on the floor of a cell in the jail at Bourg-la-Reine, after being imprisoned by villagers who had captured him on the run. They would certainly have turned him over to the Paris authorities for trial. The cause of death is unknown. Suicide was ruled out at the time, but poison, which he carried with him, is nevertheless a possibility; so is trauma or heart attack. At least he was spared the guillotine.

The French Revolution drew its intellectual strength from men and women like Condorcet. It was readied by the growth of educational opportunity and then fired by the idea of the universal rights of man. Yet as the Enlightenment seemed about to achieve political fruition in Europe, something went terribly wrong. What seemed at first to be minor inconsistencies widened into catastrophic failures. Thirty years earlier Jean-Jacques Rousseau, in *The Social Contract*, had introduced the idea that was later to inspire the rallying slogan of the Revolution: “Liberty, Equality, Fraternity.” But he had also invented the fateful abstraction of the “general will” to achieve these goals. The general will, he wrote, is the rule of justice agreed upon by assemblies of free people whose interest is only to serve the welfare of the society and of each person in it. When achieved, it forms a sovereign contract that is “always constant, unalterable, and pure.” “Each of us puts his person and all his power in common under the supreme direction of the general will, and, in our corporate capacity, we receive each member as an indivisible part of the whole.” Those who do not conform to the general will, Rousseau continued, are deviants subject to necessary force by the assembly. A truly egalitarian democracy cannot be achieved in any other way.

Robespierre, who led the Reign of Terror that overtook

the Revolution in 1793, grasped this logic all too well. He and his fellow Jacobins understood Rousseau’s necessary force to include summary condemnations and executions of all those who opposed the new order. Some 300,000 nobles, priests, political dissidents, and other troublemakers were imprisoned, and 17,000 died within the year. In Robespierre’s universe the goals of the Jacobins were noble and pure. They were, as he serenely wrote in February of 1794 (shortly before he himself was guillotined), “the peaceful enjoyment of liberty and equality, the rule of that eternal justice whose laws have been engraved . . . upon the hearts of men, even upon the heart of the slave who knows them not and of the tyrant who denies them.”

Thus took form the easy cohabitation of egalitarian ideology and savage coercion that was to plague the next two centuries. The decline of the Enlightenment was hastened not just by tyrants who used it for justification but by rising and often valid intellectual opposition. Its dream of a world made orderly and fulfilling by free intellect had seemed at first indestructible, the instinctive goal of all men. The movement gave rise to the modern intellectual tradition of the West and much of its culture. Its creators, among the greatest scholars since Plato and Aristotle, showed what the human mind can accomplish. Isaiah Berlin, one of their most perceptive historians, praised them justly as follows: “The intellectual power, honesty, lucidity, courage, and disinterested love of the truth of the most gifted thinkers of the eighteenth century remain to this day without parallel. Their age is one of the best and most hopeful episodes in the life of mankind.” But they reached too far, and their best efforts were not enough to create the sustained endeavor their vision foretold.

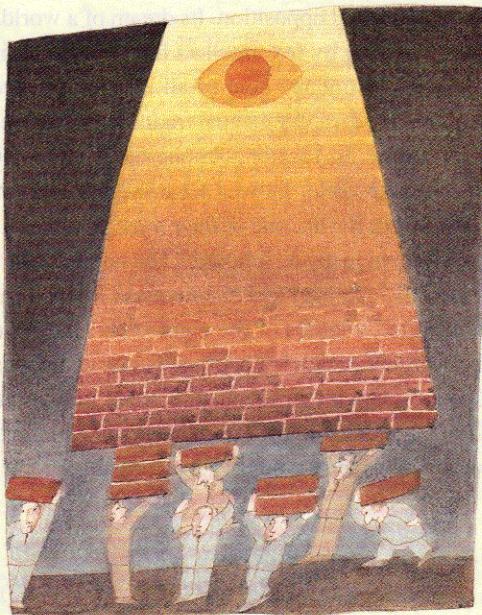
*In this winter of our cultural discontent,  
can the spirit of the Enlightenment be regained?*





## THE PERIL OF PERFECTIBILITY

**T**HIS, then, was the problem. Although reason supposedly was the defining trait of the human species, and needed only a little more cultivation to flower universally, it fell short. Humanity was not paying attention. Humanity thought otherwise. The causes of the Enlightenment's decline, which persist today, illuminate the labyrinthine wellsprings of human motivation. It is worth asking, particularly in this winter of our cultural discontent, whether the original spirit of the Enlightenment—confidence, optimism, eyes to the horizon—can be regained. And to ask in honest opposition, *Should* it be regained, or did it possess in its first conception, as some have suggested, a dark-angelic flaw? Might its idealism have contributed to the Terror, which



*Bacon's pyramid of disciplines had metaphysics at the peak.*

foreshadowed the horrendous dream of the totalitarian state? If knowledge can be consolidated, so might the "perfect" society be designed—one culture, one science—whether fascist, communist, or theocratic.

The Enlightenment itself, however, was never a unified movement. It was less a determined, swift river than a lace-work of deltaic streams working their way along twisted channels. By the time of the French Revolution it was very old. It emerged from the Scientific Revolution during the early seventeenth century and attained its greatest influence in the European academy during the eighteenth. Its originators often clashed over fundamental issues. Most engaged from time to time in absurd digressions and speculations, such as looking for hidden codes in the Bible and for the anatomical seat of the

soul. The overlap of their opinions was nevertheless extensive and clear and well reasoned enough to bear this simple characterization: They shared a passion to demystify the world and free the mind from the impersonal forces that imprison it.

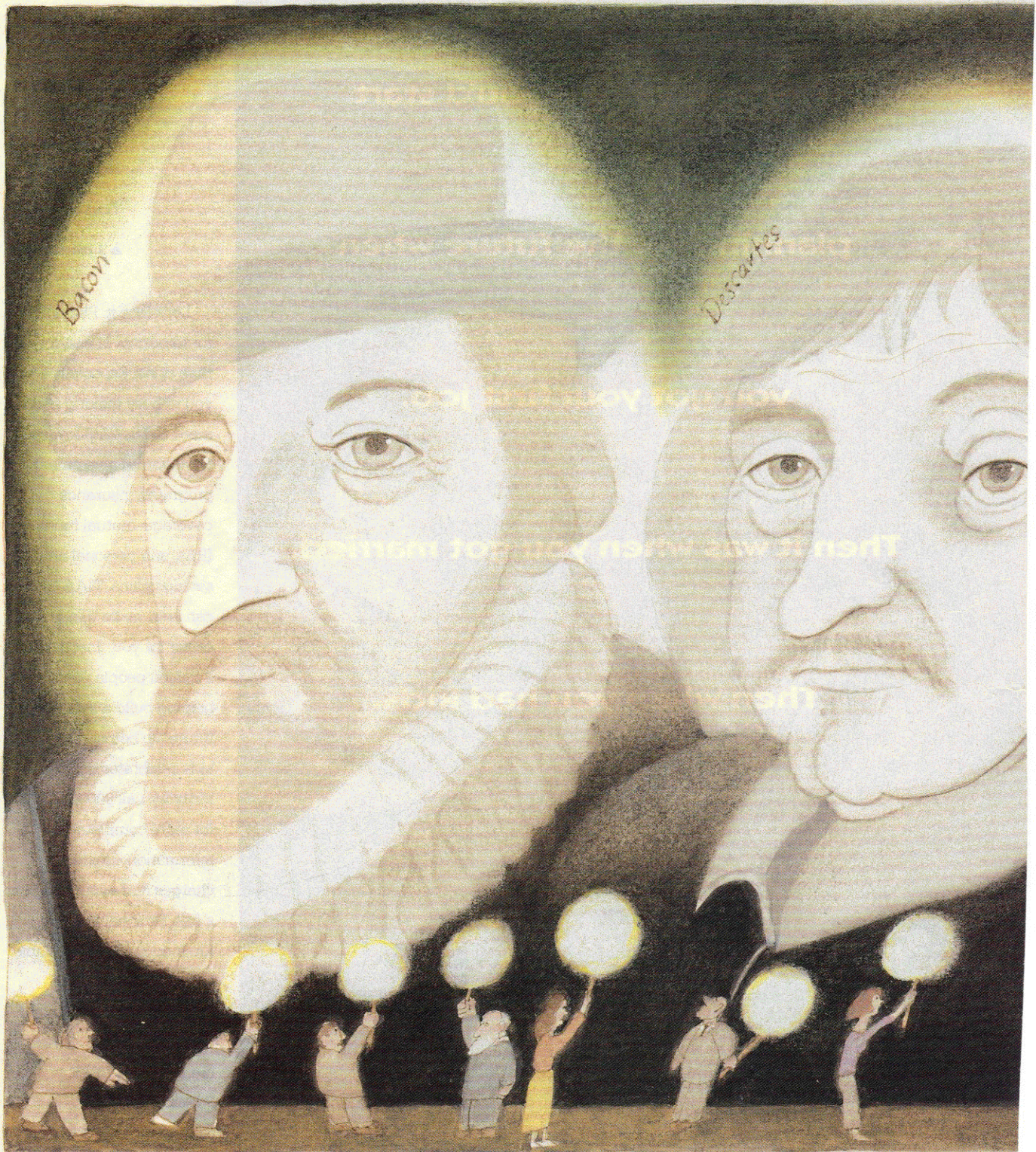
They were driven by the thrill of discovery. They agreed on the power of science to reveal an orderly, understandable universe and thereby lay an enduring base for free rational discourse. They thought that the perfection of the celestial bodies discovered by astronomy and physics could serve as a model for human society. They believed in the unity of all knowledge, individual human rights, natural law, and indefinite human progress. They tried to avoid metaphysics even as the flaws in and incompleteness of their explanations forced them to practice it. They resisted organized religion. They despised revelation and dogma. They endorsed, or at least tolerated, the state as a contrivance required for civil order. They believed that education and right reason would enormously benefit humanity. A few, like Condorcet, thought that human beings were perfectible and capable of shaping and administering a political utopia.

## FRANCIS BACON AND GOD'S MACHINE

**S**CIENCE was the engine of the Enlightenment. The more scientifically disposed Enlightenment authors agreed that the cosmos is an orderly material construct governed by exact laws. It can be broken down into entities that can be measured and arranged in hierarchies, such as societies, which are made up of persons, whose brains consist of nerves, which in turn are composed of atoms. In principle, at least, the atoms can be reassembled into nerves, the nerves into brains, and the persons into societies, with the whole understood as a system of mechanisms and forces. If one insists on a divine intervention, the Enlightenment philosophers maintained, one should think of the world as God's machine. The conceptual constraints that cloud our vision of the physical world can be eased for the betterment of humanity in every sphere. Thus Condorcet, in an era still unburdened by the ballast of complicating fact, called for the illumination of the moral and political sciences by the "torch of analysis."

The grand architect of this dream was not Condorcet, or any of the other *philosophes* who expressed it so well, but Francis Bacon. Among the Enlightenment founders, he is the one who most endures in spirit, informing us across four centuries that we must understand nature, both around us and within ourselves, in order to set humanity on the course of self-improvement. We must do it knowing that our destiny is in our own hands and that denial of the dream will lead back to barbarism. In his scholarship Bacon questioned the solidity of classical "delicate" learning—those medieval forms based on ancient texts and logical expatiation. He spurned reliance on ordinary scholastic philosophy, calling for a study of nature and the hu-



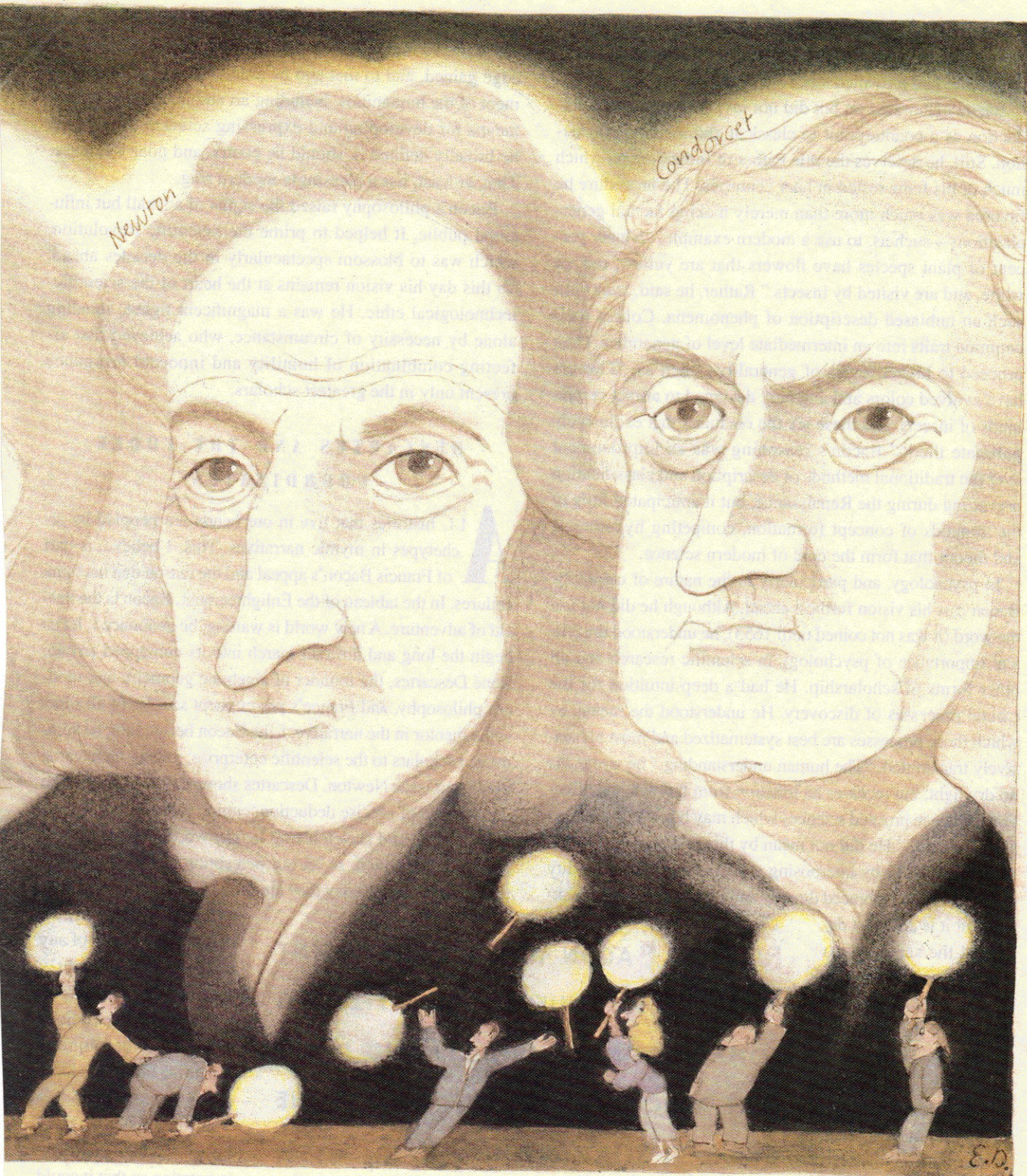


man condition on their own terms and without artifice. He observed that because “the mind, hastily and without choice, imbibes and treasures up the first notices of things, from whence all the rest proceed, errors must forever prevail, and remain uncorrected.” Thus knowledge is not well constructed but “resembles a magnificent structure that has no foundation.”

By reflecting on all possible methods of investigation available to his imagination, Bacon concluded that the best

among them for accurate thought was induction—the gathering of large numbers of facts and the detection of patterns. In order to obtain maximum objectivity, we must entertain only a minimum of preconceptions. Bacon proclaimed a pyramid of disciplines, with natural history forming the base, physics above and subsuming it, and metaphysics at the peak, explaining everything below—though perhaps in powers and forms beyond the grasp of man.





He was neither a gifted scientist ("I can not thridd needles so well") nor trained in mathematics, but he was a brilliant thinker, who founded the philosophy of science. A Renaissance man, he took, in his famous phrase, all knowledge to be his province. Then he stepped forward into the Enlightenment as the first taxonomist and master purveyor of the scientific method.

Bacon defined science broadly to include a foreshadow-

ing of the social sciences and parts of the humanities. The repeated testing of knowledge by experiment, he insisted, is the cutting edge of learning. But to him "experiment" meant more than controlled manipulations in the manner of modern science. It was all the ways in which humanity brings change into the world through information, agriculture, and industry. He believed the great branches of learning to be open-ended and constantly evolving, but he nonetheless



wrote eloquently on his belief in the underlying unity of knowledge. He rejected the sharp divisions among the disciplines that had prevailed since Aristotle.

Bacon elaborated on but did not invent the method of induction as a counterpoint to classical and medieval deduction. Still, he deserves the title Father of Induction, on which much of his fame rested in later centuries. The procedure he favored was much more than merely making factual generalizations—such as, to use a modern example, “Ninety percent of plant species have flowers that are yellow, red, or white, and are visited by insects.” Rather, he said, *start* with such an unbiased description of phenomena. Collect their common traits into an intermediate level of generality. Then proceed to higher levels of generality—such as, “Flowers have evolved colors and anatomy designed to attract certain kinds of insects, and these are the creatures that exclusively pollinate them.” Bacon’s reasoning was an improvement over the traditional methods of description and classification prevailing during the Renaissance, but it anticipated little of the methods of concept formation, competing hypotheses, and theory that form the core of modern science.

In psychology, and particularly in the nature of creativity, Bacon cast his vision furthest ahead. Although he did not use the word (it was not coined until 1653), he understood the critical importance of psychology in scientific research and all other forms of scholarship. He had a deep intuition for the mental processes of discovery. He understood the means by which those processes are best systematized and most persuasively transmitted. “The human understanding,” he wrote, “is no dry light, but receives an infusion from the will and affections; whence proceed sciences which may be called ‘sciences as one would.’” He did not mean by this to distort perception of the real world by interposing a prism of emotion. Reality ought still to be embraced directly and reported without flinching. But it is also best delivered the same way it was discovered, retaining a comparable vividness and play of the emotions.

I do not wish, by ranking Francis Bacon so high, to portray him as a thoroughly modern man. He was far from that. His friend William Harvey, a

physician and a real scientist who made a fundamental discovery, the circulation of the blood, noted drily that Bacon wrote philosophy like a Lord Chancellor. His phrases make splendid marble inscriptions and commencement flourishes. The unity of knowledge he conceived is remote from the present-day concept of consilience, far from the deliberate, systematic linkage of cause and effect across the disciplines. His stress lay instead on the common means of inductive in-

quiry that might optimally serve all the branches of learning. He searched for the techniques that best convey the knowledge gained, and to that end he argued for the full employment of the humanities, including art and fiction, as the best means for developing and expressing science. Science, as he broadly defined it, should be poetry, and poetry science. That, at least, has a pleasingly modern ring.

Bacon’s philosophy raised the sights of a small but influential public. It helped to prime the Scientific Revolution, which was to blossom spectacularly in the decades ahead. To this day his vision remains at the heart of the scientific-technological ethic. He was a magnificent figure, standing alone by necessity of circumstance, who achieved that affecting combination of humility and innocent arrogance present only in the greatest scholars.

### DESCARTES AND THE THREE COORDINATES

**A**LL histories that live in our hearts are peopled by archetypes in mythic narratives. This, I believe, is part of Francis Bacon’s appeal and the reason that his fame endures. In the tableau of the Enlightenment, Bacon is the herald of adventure. A new world is waiting, he announced; let us begin the long and difficult march into its unmapped terrain. René Descartes, the founder of algebraic geometry and modern philosophy, and France’s pre-eminent scholar of all time, is the mentor in the narrative. Like Bacon before him, he summoned scholars to the scientific enterprise; among them came the young Isaac Newton. Descartes showed how to do science with the aid of precise deduction, cutting to the quick of each phenomenon and skeletonizing it. The world is three-dimensional, he explained, so let our perception of it be framed in three coordinates. Today they are called Cartesian coordinates.

With them the length, breadth, and height of any object can be exactly specified and subjected to mathematical operations to explore the object’s essential qualities. Descartes accomplished this step in elementary form by reformulating algebraic notation so that it could

be used to solve complex problems of geometry and, further, to explore realms of mathematics beyond the visual realm of three-dimensional space.

Descartes’s overarching vision was of knowledge as a system of interconnected truths that can ultimately be abstracted into mathematics. It all came to him, he said, through a series of dreams in November of 1619, when somehow, in a flurry of symbols (thunderclaps, books, an evil spirit, a de-

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licious melon), he perceived that the universe is both rational and united throughout by cause and effect. He believed that this conception could be applied everywhere from physics to medicine—hence biology—and even to moral reasoning. In this respect he laid the groundwork for the belief in the unity of learning that was to influence Enlightenment thought profoundly in the eighteenth century.

Descartes insisted that systematic doubt was the first principle of learning. By his light, all knowledge was to be laid out and tested on the iron frame of logic. He allowed himself only one undeniable premise, captured in the celebrated phrase "*Cogito ergo sum*"—"I think, therefore I am." The system of Cartesian doubt, which still thrives in modern science, is one in which all assumptions that can be are systematically eliminated, so as to leave only one set of axioms on which rational thought can be based and experiments can be rigorously designed.

Descartes nonetheless made a fundamental concession to metaphysics. A lifelong Catholic, he believed in God as a perfect being, manifested by the power of the idea of such a being in his own mind. That given, he went on to argue for the complete separation of mind and matter. The stratagem freed him to put spirit aside and concentrate on matter as pure mechanism. In works published over the years 1637–1649 Descartes introduced reductionism, the study of the world as an assemblage of physical parts that can be broken down and analyzed separately. Reductionism and analytic mathematical modeling were destined to become the most powerful intellectual instruments of modern science. (The year 1642 was a signal one in the history of ideas: with Descartes's *Meditationes de Prima Philosophia* just published and his *Principia Philosophiae* soon to follow, Galileo died and Newton was born.)

As Enlightenment history unfolded, Isaac Newton came to rank with Galileo as the most influential of the heroes who answered Bacon's call. A restless seeker of horizons, stunningly resourceful, he invented calculus before Gottfried Leibniz, whose notation was nevertheless clearer and is the one used today. In company with analytic geometry, calculus proved to be one of the two crucial mathematical techniques in physics and, later, chemistry, biology, and economics.

In 1684 Newton formulated the mass and distance laws of gravity, and in 1687 the three laws of motion. With these mathematical formulations he achieved the first great breakthrough in modern science. He showed that the planetary orbits postulated by Copernicus and proved elliptical by Kepler could be predicted from the first principles of mechanics. His laws were exact and equally applicable to all inanimate matter, from the solar system down to grains of sand—and, of course, to the falling apple that had triggered his thinking on the subject twenty years previously (apparently a true story). The universe, he said, is not just orderly but also intelligible. At least part of God's grand design could be written with a few lines on a piece of paper.



*Science should be poetry,  
and poetry science.*

The laws of gravity and motion were a powerful beginning. And they started Enlightenment scholars thinking, Why not a Newtonian solution to the affairs of men? The idea grew into one of the mainstays of the Enlightenment agenda. As late as 1835 Adolphe Quételet was proposing "social physics" as the basis of the discipline soon to be named sociology. Auguste Comte, his contemporary, believed a true social science to be inevitable. "Men," he said, echoing Condorcet, "are not allowed to think freely about chemistry and biology, so why should they be allowed to think freely about political philosophy?" People, after all, are just extremely complicated machines. Why shouldn't their behavior and social institutions conform to certain still-undefined natural laws?

Given its unbroken string of successes during the next three centuries, reductionism may seem today the obvious best way to have constructed knowledge of the physical world, but it was not so easy to grasp at the dawn of science. Western science took the lead in the world largely because it cultivated reductionism and physical law to expand the understanding of space and time beyond that attainable by the unaided senses. The advance, however, carried humanity's self-image ever further from its perception of the remainder of the universe, and as a consequence the full reality of the universe seemed to grow progressively more alien. The ruling talismans of twentieth-century science, relativity and quantum mechanics, have become the ultimate in strangeness to the human mind. They were conceived by Albert Einstein, Max Planck, and other pioneers of theoretical physics during a search for quantifiable truths that would be known to extraterrestrials as well as to our species, and hence certifiably independent of the human mind. The physicists succeeded magnificently, but in so doing



they revealed the limitations of intuition unaided by mathematics; an understanding of nature, they discovered, comes very hard. Theoretical physics and molecular biology are acquired tastes. The cost of scientific advance is the humbling recognition that reality was not constructed to be easily grasped by the human mind. This is the cardinal tenet of scientific understanding: Our species and its ways of thinking are a product of evolution, not the purpose of evolution.

## THE CASE FOR DEISM

**W**E now pass to the final archetype of the epic tableau, the keepers of the innermost room. The more radical Enlightenment writers, alert to the implications of scientific materialism, moved to reassess God himself. They imagined a Creator obedient to his own natural laws—the belief known as deism. They disputed the theism of Judeo-Christianity, whose divinity is both omnipotent and personally interested in human beings, and they rejected the nonmaterial worlds of heaven and hell. At the same time, few dared go the whole route and embrace atheism, which seemed to imply cosmic meaninglessness and risked outraging the pious. So by and large they took a middle position. God the Creator exists, they conceded, but He is allowed only the entities and processes manifest in his own handiwork.

Deistic belief, by persisting in attenuated form to this day, has given scientists a license to search for God. More precisely, it has prompted a small number to make a partial sketch of Him (Her? It? Them?), derived from their professional meditations.

Few scientists and philosophers, however, let alone religious thinkers, take scientific theology very seriously. A

more coherent and interesting approach, possibly within the reach of theoretical physics, is to try to answer the following question: Is a universe of discrete material particles possible only with one specific set of natural laws and parameter values? In other words, does the human imagination, which can conceive of other laws and values, thereby exceed possible existence? Any act of Creation may be only a subset of the universes we can imagine. On this point Einstein is said to have remarked to his assistant Ernst Straus, in a moment of neo-deistic reflection, "What really interests me is whether God had any choice in the creation of the world." That line of reasoning can be extended rather mystically to formulate the "anthropic principle," which asserts that the laws of nature, in *our* universe at least, had to be set a certain precise way so as to allow the creation of beings able to ask about the laws of nature. Did Someone decide to do it that way?

The dispute between Enlightenment deism and theology can be summarized as follows. The traditional theism of Christianity is rooted in both reason and revelation, the two conceivable sources of knowledge. According to this view, reason and revelation cannot be in conflict, because in areas of opposition, revelation is given the higher role—as the Inquisition reminded Galileo in Rome when he was offered a choice between orthodoxy and pain. In contrast, deism grants reason the edge, and insists that theists justify revelation with the use of reason.

Traditional theologians of the eighteenth century, faced with the Enlightenment challenge, refused to yield an inch of ground. Christian faith, they argued, cannot submit itself to the debasing test of rationality. Deep truths exist that are beyond the grasp of the unaided human mind, and God will reveal them to our understanding when and by whatever means He chooses.

Given the centrality of religion in everyday life, the stand of the theists against reason seemed . . . well, reasonable. Eighteenth-century believers saw no difficulty in conducting their lives by both ratiocination and revelation. The theologians won the argument simply because they saw no compelling reason to adopt a new metaphysics. For the first time, the Enlightenment visibly stumbled.

The fatal flaw in deism is thus not rational at all but emotional. Pure reason is unappealing because it is bloodless. Ceremonies stripped of sacred mystery lose their emotional force, because celebrants need to defer to a higher power in order to consummate their instinct for tribal loyalty. In times of danger and tragedy especially, unreasoning ceremony is everything. Rationalism provides no substitute for surrender to an infallible and benevolent being, or for the leap of faith called transcendence. Most people, one imagines, would very much like science to prove the existence of God but not to take the measure of his capacity.

Deism and science also failed to systematize ethics. The Enlightenment promise of an objective basis for moral reasoning could not be kept. If an immutable secular field of

*The dark side of the Enlightenment:  
the barbarians of totalitarianism pour in.*





ethical premises exists, the human intellect during the Enlightenment seemed too weak and shifting to locate it. So theologians and philosophers stuck to their original positions, either by deferring to religious authority or by articulating subjectively perceived natural rights. No logical alternative seemed open to them. The millennium-old rules sacralized by religion seemed to work, more or less. One can defer reflection on the celestial spheres indefinitely, but daily matters of life and death require moral decisiveness.

## HOW SELF-KNOWLEDGE LEADS TO TOTALITARIANISM

**A**NOTHER, more purely rationalist objection to the Enlightenment program remains. Grant for argument's sake that the most extravagant claims of the Enlightenment's supporters proved true and scientists could look into the future to see what course of action was best for humanity. Wouldn't that trap us in a cage of logic and revealed fate? The thrust of the Enlightenment, like the Greek humanism that prefigured it, was Promethean: the knowledge it generated was to liberate mankind by lifting it above the savage world. But the opposite might occur: if scientific inquiry diminishes the conception of divinity while prescribing immutable natural laws, then humanity can lose what freedom it already possesses. Perhaps only one social order is "perfect" and scientists will find it—or, worse, falsely claim to have found it. Religious authority, the Hadrian's Wall of civilization, will be breached, and the barbarians of totalitarian ideology will pour in. Such is the dark side of Enlightenment secular thought, unveiled in the French Revolution and expressed more recently by theories of "scientific" socialism and racist fascism.

Still another concern is that a science-driven society risks upsetting the natural order of the world set in place by God, or by billions of years of evolution. Science given too much authority risks conversion into a self-destroying impiety. The godless creations of science and technology are in fact powerful and arresting images of modern culture. Frankenstein's monster and Hollywood's Terminator (an all-metal, microchip-guided Frankenstein's monster) wreak destruction on their creators, including the naive geniuses in lab coats who arrogantly forecast a new age ruled by science. Storms rage, hostile mutants spread, life dies. Nations menace one another with world-destroying technology. Even Winston Churchill, whose country was saved by radar, worried after the atom-bombing of Japan that the Stone Age might return "on the gleaming wings of Science."

## THE RISE OF ROMANTICISM

**F**OR those who thus feared science as Faustian rather than Promethean, the Enlightenment program posed a grave threat to spiritual freedom—even to life itself. What is the answer to such a threat? Revolt! Return to natural man, reassert the primacy of individual imagination and confidence in immortality. Find an escape to a higher realm through art; promote a Romantic revolution. In 1807 William Wordsworth, in words typical of the movement then spreading over Europe, evoked the aura of a primal and serene existence beyond reason's grasp.

Our Souls have sight of that immortal sea  
Which brought us hither,  
Can in a moment travel thither,  
And see the Children sport upon the shore,  
And hear the mighty waters rolling evermore.

With Wordsworth's "breathings for incommunicable powers" the eyes close, the mind soars, the inverse square distance law of gravity falls away. The spirit enters another reality, beyond the reach of weight and measure. If the constraining universe of matter and energy cannot be denied, at least it can be ignored with splendid contempt. Beyond question, Wordsworth and his fellow English Romantic poets of the first half of the nineteenth century conjured works of great beauty. They spoke truths in another tongue, and guided the arts still further from the sciences.

Romanticism also flowered in philosophy, where it placed a premium on rebellion, spontaneity, intense emotion, and heroic vision. Searching for aspirations available only to the heart, its practitioners dreamed of mankind as part of boundless nature. Rousseau, although often listed as an Enlightenment *philosophe*, was actually the founder and most extreme visionary of the Romantic philosophical movement. To him,

learning and social order were the enemies of humanity. In works from 1750 (*Discourse on the Sciences and the Arts*) to 1762 (*Emile*) he extolled the "sleep of reason." His utopia is a minimalist state in which people abandon books and other accouterments

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of intellect in order to cultivate good health and enjoyment of the senses. Humanity, Rousseau claimed, was originally a race of noble savages in a peaceful state of nature, and was later corrupted by civilization—and by scholarship. Religion, marriage, law, and government are deceptions created by the powerful for their own selfish ends. The price paid by the common man for this high-level chicanery is vice and unhappiness.



Where Rousseau invented a stunningly inaccurate form of anthropology, the German Romantics, led by Goethe, Hegel, Herder, and Schelling, set out to reinsert metaphysics into science and philosophy. The product, *Naturphilosophie*, was a hybrid of sentiment, mysticism, and quasi-scientific hypothesis. Johann Wolfgang von Goethe, pre-eminent among its expositors, wanted most of all to be a great scientist. He placed that ambition above literature, to which he became an immortal contributor. His respect for science as an idea, an approach to tangible reality, was unreserved, and he understood its basic tenets. Analysis and synthesis, he liked to say, should alternate as naturally as breathing in and breathing out. At the same time, he was critical of the mathematical abstractions of Newtonian science, thinking physics far too ambitious in its goal of explaining the universe.

Goethe can easily be forgiven. After all, he had a noble purpose—nothing less than the coupling of the soul of the humanities to the engine of science. He would have grieved had he foreseen history's verdict: great poet, poor scientist. He failed in his synthesis through lack of what is today called the scientist's instinct—not to mention the necessary technical skills. Calculus baffled him, and some said he could not tell a lark from a sparrow. But he loved nature in a profoundly spiritual way. One must cultivate a close, deep feeling for Nature, he proclaimed. "She loves illusion. She shrouds man in mist, and she spurs him toward the light. Those who will not partake of her illusions she punishes as a tyrant would punish. Those who accept her illusions she presses to her heart. To love her is the only way to approach her." In the philosophers' empyrean, I imagine, Bacon has long since lectured Goethe on the idols of the mind. Newton will have lost patience immediately.

Friedrich Schelling, the leading philosopher of the German Romantics, attempted to immobilize the scientific Prometheus not with poetry but with reason. He proposed a cosmic unity of all things, beyond the understanding of man. Facts by themselves can never be more than partial truths. Those we perceive are only fragments of the universal flux. Nature, Schelling concluded, is alive—a creative spirit that unites knower and known, progressing through greater and greater understanding and feeling toward an eventual state of complete self-realization.

In America, German philosophical Romanticism was mirrored in New England Transcendentalism, whose most celebrated adherents were Ralph Waldo Emerson and Henry David Thoreau. The Transcendentalists were radical individualists who rejected the overwhelmingly commercial nature of American society that came to prevail during the Jacksonian era. They envisioned a spiritual universe built entirely within their personal ethos. They were nevertheless more congenial to science than their European counterparts—witness the many accurate natural-history observations in *Faith in a Seed* and other writings by Thoreau.



*Postmodernists believe that one can discern no "real" reality.*

## THE AGE OF NARROW SPECIALIZATION DAWNS

NATURAL scientists, chastened by such robust objections to the Enlightenment agenda, mostly abandoned the examination of human mental life, yielding to philosophers and poets another century of free play. In fact, the concession proved to be a healthy decision for the profession of science, because it steered researchers away from the pitfalls of metaphysics. Throughout the nineteenth century knowledge in the physical and biological sciences grew at an exponential rate. At the same time, newly risen like upstart duchies and earldoms, the social sciences—sociology, anthropology, economics, and political theory—vied for territory in the space created between the hard sciences and the humanities. The great branches of learning emerged in their present form—natural sciences, social sciences, and the humanities—out of the unified Enlightenment vision.

The Enlightenment, defiantly secular in orientation while indebted and attentive to theology, had brought the Western mind to the threshold of a new freedom. It waved aside everything, every form of religious and civil authority, every imaginable fear, to give precedence to the ethic of free inquiry. It pictured a universe in which humanity plays the role of perpetual adventurer. For two centuries God seemed to speak in a new voice to humankind.

By the early 1800s, however, the splendid image was fading. Reason fractured, intellectuals lost faith in the leadership of science, and the prospects for a unity of knowledge sharply declined. The spirit of the Enlightenment lived on in political idealism and the hopes of individual thinkers. In the



ensuing decades new schools sprang up like shoots from the base of a shattered tree: the utilitarian ethics of Bentham and Mill, the historical materialism of Marx and Engels, the pragmatism of Charles Peirce, William James, and John Dewey. But the core agenda seemed irretrievably abandoned. The grand conception that had riveted thinkers during the previous two centuries lost most of its credibility.

Science traveled on its own way. It continued to double every fifteen years in practitioners, discoveries, and technical journals, as it had since the early 1700s, finally starting to level off only around 1970. Its continuously escalating success began to give credence again to the idea of an ordered, explainable universe. This essential Enlightenment premise gained ground in the disciplines of mathematics, physics, and biology, where it had first been conceived by Bacon and Descartes. Yet the enormous success of reductionism, its key method, worked perversely against any recovery of the En-



*The humanities will draw closer  
to and partly fuse with the sciences.*

lightenment program as a whole. Precisely because scientific information was increasing at a geometric pace, most researchers thought little about unification, and even less about philosophy. They thought, What works, works. They were still slower to address the taboo-laden physical basis for the workings of the mind, a concept hailed in the late 1700s as the gateway from biology to the social sciences.

There was another, humbler reason for the lack of interest in the big picture: scientists simply didn't have the requisite intellectual energy. The vast majority of scientists have never been more than journeymen prospectors. That is truer than ever today. They are professionally focused; their education

does not open them to the wide contours of the world. They acquire the training they need to travel to the frontier and make discoveries of their own—and make them as fast as possible, because life at the edge is expensive and chancy. The most productive scientists, installed in million-dollar laboratories, have no time to think about the big picture, and see little profit in it. The rosette of the U.S. National Academy of Sciences, which the 2,100 elected members wear on their lapels as a mark of achievement, contains a center of scientific gold surrounded by the purple of natural philosophy. The eyes of most leading scientists, alas, are fixed on the gold.

We should not be surprised, therefore, to find physicists who do not know what a gene is, and biologists who guess that string theory has something to do with violins. Grants and honors are given in science for discoveries, not for scholarship and wisdom. And so it has ever been. Francis Bacon, using the political skills that lofted him to the Lord Chancellorship, personally importuned the English monarchs for funds to carry forth his great scheme of unifying knowledge. He never got a penny. At the height of his fame Descartes was ceremoniously awarded a stipend by the French court. But the account remained unfunded, helping to drive him to the more generous Swedish court, in the “land of bears between rock and ice,” where he soon died of pneumonia.

The same professional atomization afflicts the social sciences and the humanities. The faculties of higher education around the world are a congeries of experts. To be an original scholar is to be a highly specialized world authority in a polyglot Calcutta of similarly focused world authorities. In 1797, when Jefferson took the president's chair at the American Philosophical Society, all American scientists of professional caliber and their colleagues in the humanities could be seated comfortably in the lecture room of Philosophical Hall. Most could discourse reasonably well on the entire world of learning, which was still small enough to be seen whole. Their successors today, including 450,000 holders of the doctorate in science and engineering alone, would overcrowd Philadelphia. Professional scholars in general have little choice but to dice up research expertise and research agendas among themselves. To be a successful scholar means spending a career on membrane biophysics, the Romantic poets, early American history, or some other such constricted area of formal study.

Fragmentation of expertise was furthered in the twentieth century by modernism in the arts, including architecture. The work of the masters—Braque, Picasso, Stravinsky, Eliot, Joyce, Martha Graham, Gropius, Frank Lloyd Wright, and their peers—was so novel and discursive as to thwart generic classification, except perhaps for this: The modernists tried to achieve the new and provocative at any cost. They identified the constraining bonds of tradition and self-consciously broke them. Many rejected realism of expression in order to explore the unconscious. Freud, as much a



literary stylist as a scientist, inspired them and can justifiably be included in their ranks. Psychoanalysis was a force that shifted the attention of modernist intellectuals and artists from the social and political to the private and psychological. Subjecting every topic within their domain to the "ruthless centrifuge of change," in the American historian Carl Schorske's phrase, they meant proudly to assert the independence of twentieth-century high culture from the past. They were not nihilists; rather, they sought to create a new level of order and meaning. They were complete experimentalists who wished to participate in a century of radical technological and political change and to fashion part of it entirely on their own terms.

Thus the free flight bequeathed by the Enlightenment, which disengaged the humanities during the Romantic era, had by the middle of the twentieth century all but erased hope for the unification of knowledge with the aid of science. The two cultures described by C. P. Snow in his 1959 Rede Lecture, the literary and the scientific, were no longer on speaking terms.

### THE RIDDLE OF POSTMODERNISM

**A**LL movements tend toward extremes, which is approximately where we are today. The exuberant self-realization that ran from Romanticism to modernism has given rise now to philosophical postmodernism (often called post-structuralism, especially in its more political and sociological expressions). Postmodernism is the ultimate antithesis of the Enlightenment. The difference between the two can be expressed roughly as follows: Enlightenment thinkers believed we can know everything, and radical postmodernists believe we can know nothing.

The philosophical postmodernists, a rebel crew milling beneath the black flag of anarchy, challenge the very foundations of science and traditional philosophy. Reality, the radicals among them propose, is a state constructed by the mind. In the exaggerated version of this constructivism one can discern no "real" reality, no objective truths external to mental activity, only prevailing versions disseminated by ruling social groups. Nor can ethics be firmly grounded, given that each society creates its own codes for the benefit of equivalent oppressive forces.

If these premises are correct, it follows that one culture is as good as any other in the expression of truth and morality, each in its own special way. Political multiculturalism is justified;

each ethnic group and sexual preference in the community has equal validity and deserves communal support and mandated representation in educational agendas—that is, again, if the premises are correct. And they must be correct, say their promoters, because to suggest otherwise is bigotry, which is a cardinal sin. Cardinal, that is, if we agree to waive in this one instance the postmodernist prohibition against universal truth, and all agree to agree for the common good. Thus

Rousseau redivivus.

Postmodernism is expressed more explicitly still in deconstruction, a technique of literary criticism. Its underlying premise is that each author's meaning is unique to himself; neither his true intention nor anything else connected to objective re-

ality can reliably be determined. His text is therefore open to fresh analysis and commentary from the equally solipsistic world in the head of the reviewer. But the reviewer, too, is subject to deconstruction, as is the reviewer of the reviewer, and so on in infinite regress. That is what Jacques Derrida, the creator of deconstruction, meant when he stated the formula "*Il n'y a pas de hors-texte*" ("There is nothing outside the text"). At least, that is what I think he meant, after reading him, his defenders, and his critics with some care. If the radical postmodernist premise is correct, we can never be sure what he meant. Conversely, if that *is* what he meant, perhaps we are not obliged to consider his arguments further. This puzzle, which I am inclined to set aside as the "Derrida paradox," is similar to the Cretan paradox (a Cretan says "All Cretans are liars"). It awaits solution, but one should not feel any great sense of urgency in the matter.

Scientists, held responsible for what they say, have not found postmodernism useful. The postmodernist posture toward science, in turn, is one of subversion. It contains what appears to be a provisional acceptance of gravity, the periodic table, astrophysics, and similar stanchions of the external world, but in general the scientific culture is viewed as just another way of knowing, and, moreover, a mental posture contrived mostly by European and American white males.

One is tempted to place postmodernism in history's curiosity cabinet, alongside theosophy and transcendental idealism, but it has seeped by now into the mainstream of the social sciences and the humanities. It is viewed there as a technique of metatheory (theory about theories), by which scholars analyze not so much the subject matter of a scientific discipline as the cultural and psychological factors that explain why particular scientists think the way they do. The analyst places emphasis on "root metaphors," those ruling images in the thinker's mind whereby he designs theories

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and experiments. Here, for example, is the psychologist Kenneth Gergen explaining how modern psychology is dominated by the metaphor of human beings as machines:

Regardless of the character of the person's behavior, the mechanist theorist is virtually obliged to segment him from the environment, to view the environment in terms of stimulus or input elements, to view the person as reactive to and dependent on these input elements, to view the domain of the mental as structured (constituted of interacting elements), to segment behavior into units that can be coordinated to the stimulus inputs, and so on.

Put briefly, and to face the issue squarely, psychology is at risk of becoming a natural science. As a possible remedy for those who wish to keep it otherwise, and many scholars do, Gergen cites other, perhaps less pernicious root metaphors of mental life that might be considered, such as dramaturgy, the marketplace, and rule-following. Psychology, if not allowed to be contaminated with too much biology, can accommodate endless numbers of theoreticians in the future.

As diversity of metaphors has been added to ethnic diversity and gender dualism and then politicized, schools and ideologies have multiplied explosively. Usually leftist in orientation, the more familiar modes of general postmodernist thought include Afrocentrism, constructivist social anthropology, "critical" (that is, socialist) science, deep ecology, ecofeminism, Lacanian psychoanalysis, Latourian sociology of science, and neo-Marxism—to which must be added all the bewildering varieties of deconstructionism and New Age holism swirling round about and through them.

Their adherents fret upon the field of play, sometimes brilliantly, usually not, jargon-prone and elusive. Each in his own way seems to be drifting toward that *mysterium tremendum* abandoned in the seventeenth century by the Enlightenment—and not without the expression of considerable personal anguish. Of the late Michel Foucault, the great interpreter of political power in the history of ideas, poised "at the summit of Western intellectual life," the literary critic George Scialabba has perceptively written,

Foucault was grappling with the deepest, most intractable dilemmas of modern identity. . . . For those who believe that neither God nor natural law nor transcendent Reason exists, and who recognize the varied and subtle ways in which material interest—power—has corrupted, even constituted, every previous morality, how is one to live, to what values can one hold fast?

How and to what indeed? To solve these disturbing problems, let us begin by simply walking away from Foucault, and existentialist despair. Consider this rule of thumb: to the extent that philosophical positions both confuse us and close doors to further inquiry, they are likely to be wrong.

To Foucault I would say, if I could (and I do not mean to sound patronizing), it's not so bad. Once we get over the

shock of discovering that the universe was not made with us in mind, all the meaning the brain can master, and all the emotions it can bear, and all the shared adventure we might wish to enjoy, can be found by deciphering the hereditary orderliness that has borne our species through geological time and stamped it with the residues of deep history. Reason will be advanced to new levels, and emotions played in potentially infinite patterns. The true will be sorted from the false, and we will understand one another very well, the more quickly because we are the same species and possess biologically similar brains.

To those concerned about the growing dissolution and irrelevance of the intelligentsia, which is indeed alarming, I suggest that there have always been two kinds of original thinkers—those who upon viewing disorder try to create order, and those who upon encountering order try to protest it by creating disorder. The tension between the two is what drives learning forward. It lifts us upward on a zigzagging trajectory of progress. And in the Darwinian contest of ideas order always wins, because—simply—that is the way the real world works.

As today's celebrants of unrestrained Romanticism, the postmodernists enrich culture. They say to the rest of us, Maybe, just maybe, you are wrong. Their ideas are like sparks from fireworks explosions that travel away in all directions, devoid of following energy, soon to wink out in the dimensionless dark. Yet a few will endure long enough to cast light in unexpected places. That is one reason to think well of postmodernism, even as it menaces rational thought. Another is the relief it affords those who have chosen not to encumber themselves with a scientific education. Another is

The key to unifying the humanities  
and the sciences is consilience.





the small industry it has created within philosophy and literary studies. Still another, the one that counts most, is the unyielding critique of traditional scholarship it provides. We will always need postmodernists or their rebellious equivalents. For what better way to strengthen organized knowledge than continually to defend it from hostile forces? John Stuart Mill correctly observed that teacher and learner alike fall asleep at their posts when there is no enemy in the field. And if somehow, against all the evidence, against all reason, the linchpin falls out and everything is reduced to epistemological confusion, we will find the courage to admit that the postmodernists were right, and in the best spirit of the Enlightenment we will start over again. Because, as the great mathematician David Hilbert once said, capturing so well that part of the human spirit expressed through the Enlightenment, "*Wir müssen wissen. Wir werden wissen.*" ("We must know, we will know.")

### THE PROMISE OF CONSILIENCE

**I**F contemporary scholars work to encourage the consilience of knowledge, I believe, the enterprises of culture will eventually devolve into science—by which I mean the natural sciences—and the humanities, particularly the creative arts. These domains will continue to be the two great branches of learning in the twenty-first century. Social science will split within each of its disciplines, a process already rancorously begun, with one part folding into or becoming continuous with biology, and the other fusing with the humanities. Its disciplines will continue to exist but in radically altered form. In the process the humanities, embracing philosophy, history, moral reasoning, comparative religion, and interpretation of the arts, will draw closer to the sciences and partly fuse with them.

The confidence of natural scientists, I grant, often seems overweening. Science offers the boldest metaphysics of the age: the faith that if we dream, press to discover, explain, and dream again, thereby plunging repeatedly into new terrain, the world will somehow become clearer and we will grasp the true strangeness of the universe. And the strangeness will all prove to be connected and make sense.

In his 1941 classic *Man on His Nature*, the British neurobiologist Charles Sherrington spoke of the brain as an "enchanted loom," perpetually weaving a picture of the external world, tearing down and reweaving, inventing other worlds, creating a miniature universe. The communal mind of literate societies—world culture—is an immensely larger loom. Through science it has gained the power to map external reality far beyond the reach of a single mind, and in the arts it finds the means to construct narratives, images, and rhythms immeasurably more diverse than the products of any solitary genius. The loom is the same for both enterprises, for science

and for the arts, and there is a general explanation of its origin and nature and thence of the human condition.

In education the search for consilience is the way to renew the crumbling structure of the liberal arts. During the past thirty years the ideal of the unity of learning, bequeathed to us by the Renaissance and the Enlightenment, has been largely abandoned. With rare exceptions American colleges and universities have dissolved their curricula into a slurry of minor disciplines and specialized courses. While the average number of undergraduate courses per institution has doubled, the percentage of mandatory courses in general education has dropped by more than half. Science was sequestered at the same time; as I write, only a third of colleges and universities require students to take at least one course in the natural sciences. The trend cannot be reversed by force-feeding students with some of this and some of that across the branches of learning; true reform will aim at the consilience of science with the social sciences and the humanities in scholarship and teaching. Every college student should be able to answer this question: What is the relation between science and the humanities, and how is it important for human welfare?

Every public intellectual or political leader should be able to answer that question as well. Already half the legislation coming before Congress has important scientific and technological components. Most of the issues that vex humanity daily—ethnic conflict, arms escalation, overpopulation, abortion, environmental destruction, and endemic poverty, to cite several of the most persistent—can be solved only by integrating knowledge from the natural sciences with that from the social sciences and the humanities. Only fluency across the boundaries will provide a clear view of the world as it really is, not as it appears through the lens of ideology and religious dogma, or as a myopic response solely to immediate need. Yet the vast majority of our political leaders are trained primarily or exclusively in the social sciences and the humanities, and have little or no knowledge of the natural sciences. The same is true of public intellectuals, columnists, media interrogators, and think-tank gurus. The best of their analyses are careful and responsible, and sometimes correct, but the substantive base of their wisdom is fragmented and lopsided.

A balanced perspective cannot be acquired by studying disciplines in pieces; the consilience among them must be pursued. Such unification will be difficult to achieve. But I think it is inevitable. Intellectually it rings true, and it gratifies impulses that arise from the admirable side of human nature. To the extent that the gaps between the great branches of learning can be narrowed, diversity and depth of knowledge will increase. They will do so because of, not despite, the underlying cohesion achieved. The enterprise is important for yet another reason: It gives purpose to intellect. It promises that order, not chaos, lies beyond the horizon. Inevitably, I think, we will accept the adventure, go there, and find what we need to know. ☞