

what place for science in our culture at the “end of the modern era?”

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Prefatory note

It is the very essence of democracy that any institution's claim to a measure of authority invites, almost automatically, scrutiny by reasoned counter-argument. That is also true, and has been for centuries, for the authority that has been asserted on behalf of science and its place in Western culture.

But from time to time, those reasoned counter-arguments have been submerged under a flood of passionate, unreasoned, even sensationalist attacks on the place of scientific knowledge. (One thinks here, for example, of the “Bankruptcy of Science” movement in the nineteenth century.) The same process seemed to me to be beginning to happen some years ago, when the following pages were written in order to illustrate and to understand this social phenomenon, as well as to alert some among the usually placid scientific community to notice the challenge and to act upon it.

The hope was then also that—in part owing to the extraordinary advances continually being made in modern science and in its useful applications in daily life—those extreme voices would be muted. However,

this has not happened. In fact, a combination of quite different forces have been at work (at least in the USA and some European countries) to swing the pendulum of antagonism against the authority of science—in academe, in popular culture, among very visible politicians, even among some theologians. There has been a continued increase in books with such titles as The End of Science; in scholars' publications with the central arguments that the scientific experimental method by its very essence “arose out of human torture transferred onto nature”; in highly-funded attacks on the biology of evolution; among some postmodern philosophers and sociologists, arguing that we are now “at the end of modernity,” and that the concept “nature,” having no validity, makes doing science an attempt at careerism; and in the suppression, at the highest level of government, of widely agreed-upon scientific findings regarding dangers to the environment and public health.

In sum, the observations and findings presented below regarding the place of science in our culture have grown even more relevant in our time.

Behind every act in the life of a scientist—whether it be the choice of a research program, or interaction with students, the public and the media, or the never-ending search for funding, or advice asked by government officials—there is a hidden factor that in large part determines the outcome. That factor is how society at large regards the place of science in our culture. Most practitioners of science would claim they have little interest or expertise to concern themselves with such a seemingly complex and amorphous problem—at least not until the time comes, as it does periodically, when they begin to notice that their largely unconscious assumptions about the relations of science and the wider polity are being severely challenged.

Such a time has arrived once more. Here and there, intellectuals are waking up to the fact that increasingly such concepts as the "end of the modern era," the "end of progress," and the "end of objectivity," originating from parts of academe, from eloquent popularizers, and even from members of Congress, are making an unquestioned place for themselves in the public mind, with surprisingly little audible opposition from leaders of the scientific establishment. But far from being a passing phase, the movement—different from the anti-science phenomenon that I have tried to analyze elsewhere¹—signals the resurgence of an old, recurring rebellion against some of the Enlightenment-based presuppositions of Western civilization, particularly against the claim of science that it can lead to a kind of knowledge that is progressively improvable, in principle universally accessible (i.e., intersubjective), and potentially valuable and civilizing. The impact of the resurgence of this reaction on the life of the scientist, on the public understanding of science generally, and on the legislation of science policy, is measurably growing and will become palpable even for the least attentive.

The aim of this essay is to help understand the movement, its main sources, and its driving ambitions. To this end it is well to begin with a survey of some of the chief theorists on the question of what role, if any, science may play in our culture, and its effects on key legislators in the US who are now redesigning the direction and conduct of science. In effect one must look back beyond the so-called implicit "contract" forged in the aftermath of World War II between science and society.

That contract, still the dominant myth among the majority of scientists even while it hardly corresponds to reality today, was the result of a more innocent phase, when for a few decades the pursuit of scientific knowledge was widely thought—above all by the scientists themselves—to embody the classical values

of Western civilization, starting with the three primary virtues of truth, goodness, and beauty: when science tended to be praised as a central truth-seeking and enlightening process in modern culture—one might call it the Newtonian search for Omnipotence; when science was thought to embody a positive ethos in an imperfect world, both through its largely self-correcting practice of honor in science, and through its tendency to lead to applications that might improve the human condition and ward off the enemies of our form of society—a Baconian search for a benign sort of Omnipotence; when the discovery of beauty in the structure, coherence, simplicity and rationality of the world was thought of as a Keplerian enchantment, the highest reward for the exhausting labor.

Before the euphoria ended

The last time the optimistic description just given could have been said to be generally taken for granted, at least in the US, was the period following the ending of World War II. It was embodied also in the famous Vannevar Bush report, *Science, the Endless Frontier*, of 1945, which became a main driving force of science policy in that country. Because it is such a convenient example of modern post-Enlightenment optimism about the role of science in culture, one that so many scientists tacitly assume to be still operative, it will be illuminating to look at the main thrust of that document.

In November 1944, President Franklin D. Roosevelt requested from Vannevar Bush, the head of the wartime Office of Scientific Research and Development, a report that would outline how, in the postwar world, research in the natural sciences—he called it "the new frontiers of the mind"—could be strengthened and put to service for the nation and humanity. Roosevelt was particularly interested in three results: waging a new "war of science against disease," "discovering and developing scientific talent in American youth," and designing a new system of vigorous federal support for scientific research in the public and private sectors. Beyond those, he argued that science's applications, so useful during the bitter war to preserve the world from fascist dictatorship (with the successes of the Allies' radar and antisubmarine devices the most striking examples at that time), now could be harnessed to "create a fuller and more fruitful employment, and a fuller and more fruitful life."

Vannevar Bush's detailed response came less than eight months later, the result of a crash program by an impressive brain trust of about forty experts from industry, academe, and government. Roosevelt had died, but with the war's successful end in sight, the

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Holton, Gerald. *Science and Anti-Science*. Cambridge, MA: Harvard University Press, 1993, chapter 6.

American administration proved generally hospitable to the report's ideas. While some of the details were too optimistic and others were modified in practice (often to Bush's dismay), his vision, it is generally agreed, set the stage for the development of new institutions for the support of science during the following decades, and paralleled the generally favorable popular attitudes that were prerequisites for the actions. The base was laid for global leadership in many branches of basic science. Not until the Vietnam war escalated was there substantial popular disenchantment both with governmental authority, with the widely visible use of sophisticated technology in a hopeless and unpopular war, and by implication with science that presumably could help give birth to such abuse. It signaled the end of what might be called a rather euphoric phase in the relation of science and society in this century.

The Bush report, together with the rival proposals by Senator Harley Kilgore, were historic exemplars of the science-based progressivism reigning in its time, which saw science and democracy as natural allies in the service of the ideal of empowerment and instruction of the polity as a whole. In this sense, they were part of the American dream as far back as Benjamin Franklin and his fellow statesmen-science amateurs. Vannevar Bush himself hinted as much in the brief preface to his report, taking courage from the fact that, as he put it, "the pioneer spirit is still vigorous within the nation." And to make the connection with the tradition of Condorcet even more explicit, he added a sentence that, while presenting the reigning opinion of a citizen of the mid-1940s, is likely to be rejected today by many who think of themselves as the children of the 1960s and 1970s. He wrote: "Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress." One could hear an echo of Thomas Jefferson's formula: "The important truths [are] that knowledge is power, knowledge is safety, knowledge is happiness."

Bush and his contemporaries could hardly have imagined that by the early 1990s those hopes had begun to be rejected, even at the highest levels—that, for example, a key person in the US Congress for science policy could imply (as we shall see in more detail later) that science and technology alone can be held to account for the whole sorry list of failures over decades of misdirected political leadership. He said: "Global leadership in science and technology has not translated into leadership in infant health, life expectancy, rates of literacy, equality of opportunity, productivity of workers, or efficiency of resource consumption. Neither has it overcome failing

education systems, decaying cities, environmental degradation, unaffordable health care, and the largest national debt in history."² And another highly placed observer, formerly the Director of the National Science Foundation, exulted: "The days of Vannevar Bush are over and gone [...] the whole world is changing."

The changing balance of sentiments

After this reminder of a mid-century worldview predominant before the generation now in leadership positions came on the scene, we turn from the level of momentary vagaries to come closer to understanding the causal mechanisms responsible for the changes in the place assigned to science at significant stages in the intellectual history of the past hundred years. For if we know the general causes in the variation of the underlying ideology, we shall better understand the changes in policy toward science at a given moment.

Here we must confront at once the question of whether these changes are gradual, and part of an evolutionary development, or are so sudden that, as if in a political revolution, one passes discontinuously from the end of one age to the beginning of another. If the latter is the case, we would now be passing through a rupture of history, with "modern" behind us and "postmodern" right, left, and all before us. While I doubt this is the case—and it certainly is not visible in the content of science as against some of the current writings about science today—a fashion in history proper has for some time been trying to discern the arrival of a new age. Periodization, the arranging of the flow of events into clearly separate eras, is a common tool, although applied more wisely from the safe distance of retrospection. That is how we got such schoolbook chapters as "The Age of Reason" or "The Progressive Era in America" around the turn of the nineteenth century.

A chastening example of that whole genre was provided by the American historian Henry Adams. At the beginning of the twentieth century, he had been impressed by the publications of the physicist and chemist J. Willard Gibbs of Yale on the phase rule for understanding heterogeneous equilibria. Adams was also fascinated by the strange idea of some physicists of that day that the phase rule can serve, by analogy, as a means for putting into hierarchical order the following sequence: solid, fluid, gas, electricity, ether, and space—as if they formed a sequence of phases. Stimulated by such ideas, Adams believed that thought, too, passed in time through different phases, each representing a different period. In his essay of 1909, "The Rule of Phase Applied to History," Adams came to a remarkable conclusion about the imminent passing

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BROWN, George E. Jr., quoted in *Science*, vol. 260, May 7, 1993, 735.

of modernity: "The future of Thought," he wrote, "and therefore of History, lies in the hands of the physicist, and [...] the future historian must seek his education in the world of mathematical physics [...] [If necessary] the physics departments will have to assume the task alone." Henry Adams' conclusion might fairly have been called in its own day a declaration of what the postmodern age would look like.

Today's formulation is likely to be exactly the opposite one. I cite this example—and many others come to mind—to signal my discomfort with trying to divide history into distinct periods. A less rigid and more workable notion is to recognize that at any given time and place, even during a period when a civilization appears to be in a more or less settled state of dynamic equilibrium, there exist simultaneously several competing and conflicting ideologies within the momentary heterogeneous mixture of outlooks. As Leszek Kolakowski noted, "It is certain that modernity is as little modern as are the attacks on modernity. [...] The clash between the ancient and the modern is probably everlasting and we will never get rid of it, as it expresses the natural tension between structure and evolution, and this tension seems to be biologically rooted; it is, we may believe, an essential characteristic of life."³

It is sometimes possible in retrospect to identify one of the competing worldviews as the most dominant one for a longer or shorter period. But what is also likely to occur when followed in real time are two effects. The first is that each of the different competing groups works fervently to raise its own ideology to a position where it would be accepted as the "taste of the time" or the "climate of opinion" which characterizes that particular age and region. The newest and most ambitious one *will also be trying as part of its agenda to delegitimize the claims of its main rivals*. Especially when the previously relatively stable equilibrium begins to crumble, the pandemonium of contrasting voices gets louder. Some partial victors rise to be major claimants above the rest, and one of them may even be generally recognized for a while as the embodiment of the new worldview or "sentiment" of the society. Secondly, in this constant seesaw of changing historic forces, mankind's inherent liability to engage in over-ambition or one-sidedness may infect some of these claimants (not excluding, on occasion, scientists). This is the tendency, as Hegel had warned, toward "the self-infinitization of man," or simply to *yield to excess*—which, in turn can generate, in reaction, the same sort of excess among the opposing claimants. Recognizing these two facts is, in my view, central for understanding the course of culture in our time.

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Kolakowski, Leszek. *Modernity on Endless Trial*. University of Chicago, 1960, 4.

In this general struggle, from that of Apollo vs. Dionysus in Greece to this day, the specific, more limited question of the place assigned to the scientific conception of the world has always played a part. Sometimes this place has been at the cherished core of the rising or victorious overall worldview, as noted above; sometimes it has found itself embedded in the sinking or defeated one, and then was even accused of nourishing a great variety of sins against the better interests of humanity.

Historians of ideas have mapped the changing forms of the general contrary trends. Wise political leaders, too, have at times watched with apprehension as the net balance of prevailing sentiments has taken a turn, for as Jefferson said, "It is the manner and spirit of a people which preserve a republic in vigor. A degeneracy in these is a canker which soon eats into the heart of its laws and constitution." Weighty scholarship has chronicled how one of the world conceptions, and the scientific position within it, gained predominance over the others for some decades in significant segments of Western culture—an example is Robert K. Merton's early study on science and seventeenth-century Puritanism. There is also much documentation that such sentiments subsequently gave ground, as the overall balance of benignity or distress moved the other way for some more decades. As to the practicing scientists themselves, most of them have paid little attention to this constant seesaw of sentiments, except to weigh in now and then as promoters of the positive swings, or occasionally to become victims of the negative ones.

Today, this oscillating spectacle, so engrossing to the scholar, has ceased to be merely the site for the research of historians. The general balance among the contending elements, and with it the attitude of traditional patrons, is changing before our eyes. Studying this current drama is as fascinating and fruitful for the historian of ideas, whose perspective I shall be taking here, as the appearance of a supernova may be for an astronomer. But in both cases, the present state is the product of an historic process, the latest member of a motley progression.

Toward a "Monistic Century"

Let us therefore look at some of those claimants for representing the climate over the past hundred years up to the present—a sequence of selected samples meant to be analogous to stages in the growth of a culture of cells seen under the microscope. Our first sample concerns an event as a new century was signaling its beginning: the World's Columbia Exposition at Chicago in 1893. The fair was intended as a triumphant celebration of human and social progress

in all fields—above all, industrial, scientific, and architectural. The big attractions were Machinery Hall, the Electricity Building, the Electric Fountain, and the halls on Transportation and Mines. On the opening day, US President Grover Cleveland was on hand to push a button that turned on an abundance of electric lights and motors. (Electric light bulbs and ac motors were still fairly new.) This caused such an excited forward surging of the thousands of spectators that many fainted in the crush. One may safely assume that few among the twenty-seven million attendees during the Exposition worried about, say, the ill effects of rapid industrialization. And few if any would have guessed that, just a century later, at a World's Fair held in South Korea, the official US exhibit, as if in obeisance to a new *Zeitgeist*, was reportedly dedicated entirely to the detritus of the post-industrial world, featuring mounds of broken machinery and views of festering nuclear disposal sites; or that the current and permanent exhibition at Washington's Smithsonian Institution Museum of American History, "Science in American Life," devotes the major part of its space to an exposé of the hazards of science and the public's alleged disillusionment with technology.

Another indication of how much the worldview changed during one century is that one of the major events of the Exposition of 1893 was a spectacular World's Parliament of Religions. Personal religion is, and always has been, close to the hearts of most Americans. But it now seems surprising that in a setting glorifying science and industry, hundreds of religious leaders from all parts of the world met to present their views in two hundred sessions during seventeen days. It was a colorful affair, with Hindus, Buddhists, Jains, Jews, Protestants, Catholics, adherents of Shinto and Zoroaster, and so forth, all meeting together in their robes "for a loving conference," in the words of the chairman of the Parliament, J. H. Barrows. The purpose was clear. As it was for the Exposition as a whole, the subtext of that Parliament of Religions was also progress and harmonious unity. Hence the Exposition, Barrows said, could exclude religion no more than it could exclude electricity. Science was invoked as an ally in reaching a higher unity while serving the needs of mankind.

One of the passionate believers that science, religion, and indeed cultural activities are aspects of one grand unification program was one of the organizers of the Parliament of Religions, Paul Carus, a publisher now remembered mainly for having brought the writings of Ernst Mach to readers in the US. The title of his presentation⁴ was nothing less than "Science, a Religious Revelation." His was a sort

of anticlerical post-Christian Deism, much of which would have appealed to some American statesmen-philosophers of an earlier century. Individual dignity, Carus thought, can only be found through the discovery of truth, and that is the business of science. Hence, he announced, "through science, God speaks to us." One did not have to choose between the Virgin and the Dynamo; rather, the laboratory was the true cathedral, and vice versa. As the masthead of his journal *The Open Court* put it, he was "devoted to the science of religion [and] the religion of science."

Carus typified a popular, science-favoring universalism of that time, which today is severely challenged, both from the right and from the left. I have chosen Carus because his world picture was a good example of the then prominent movement, *Modern Monism*, based on the belief in a "unitary world conception." It arose essentially as an anti-thematic response against the Cartesian dualism of the material vs. the mental, and against the multiplicity of common sense experience, with its starting point in personal individuality. The movement on behalf of Monism had the enormous ambition, in the words of Carus, "to direct all efforts at reform, and to regenerate our entire spiritual life in all its various fields." This meant of course replacing conventional religion with what Carus called the "Religion of Truth," where Truth is defined as "the description of fact [...] ascertainable according to the methods of scientific inquiry." In this sense, "science is revelation"; and in this way one would overcome the old, unacceptable dualism of scientific truths vs. religious truths.

The head of the small but ambitious international Monistic movement was the great German chemist Wilhelm Ostwald (Nobel Prize, 1909). Whereas most modern scientists are quite aware of the limits even within their research—as Max Planck said in 1931, "a science is never in a position completely and exhaustively to solve the problem it has to face"—the publications of the Monistic movement show that it hoped every aspect of culture, life, and society would be guided by Monistic ideas, from the education of children to the economy of nations, and of course within the research program of science itself. Thus Ernst Haeckel, another patron of the movement, predicted that physical science would eventually trace back all matter to a "single original element."

Despite the philosophical naïveté of the leaders, the movement attracted for a time an enthusiastic following. In Germany, it had branches in forty-one cities, and even organized public mass demonstrations against the Church. One must perhaps allow for the effects on them of having had to live under the

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Barrows, John Henry, ed. *The World's Parliament of Religions*. Chicago: The Parliament Publication Co., 1893. Vol. II: 978–981.

reactionary political clericalism of Germany. But I have intentionally chosen this case of "scientism," of excess on the side of a small minority of scientists, as my first example of *the rhetoric of a polarizing over-reaching by many movements, before and since, on either side.* Thus, caught up in this fervor, Ostwald, with hubris unequaled by the few remaining captives of scientism today, was propelled to the heights of over-ambition, with such claims as these in 1911: "We expect from science the highest that mankind can produce and win on this earth. [...] Everything that mankind, in terms of its wishes and hopes, its aims and ideals, combines in the concept God, is fulfilled by science." And finally, "Science, now and with immeasurable success takes the place of the divine." Ostwald added the prophecy that "we see arrive the Monistic Century. [...] It will inaugurate a new epoch for humanity, just as 2,000 years ago the preaching of the general love for humanity had inaugurated an epoch."⁵

But soon after this publication, neither the Monistic nor the Christian base for kindness and love of fellow man had triumphed. Instead, war, which William James called the inevitable "bloody nurse of history," had taken charge. Strangely enough, it was Henry Adams who had sensed that the trend would be ultimately against a Monistic Century. Writing in 1905 in his autobiography, *The Education of Henry Adams*, he identified the course of history as away from Unity and toward fragmentation and multiplicity. Indeed, in the aftermath of World War I, the idea of progress and optimism about the place of science in culture were war casualties. The balance had swung the other way. The only major movement with large political ambition that continued to claim a scientific basis was of course Marxism, especially as defended by Lenin in his 1908 book, *Materialism and Empirio-Criticism*. The assertion that Marxism-Leninism, the founding ideology of the Soviet Union, had anything to do with real science is a rhetorical device, one of that century's great delusions even if this propaganda was taught to every child in Communist countries. It is disproved, not least by the faulty analysis of science and its philosophy in Lenin's own book, and by the widespread mistreatment that Soviet scientists experienced when their theories did not please their government.

Spengler's prediction of the end of science

Perhaps the most widely read attack against the claims of optimistic science appeared as the war was ending in 1918, and later it deeply influenced such theoreticians of history as Arnold Toynbee and Lewis Mumford. The book was *The Decline of the West*, written by a German mathematics teacher, Oswald Spengler. No quick

summary can do justice to that richly baroque work, but the point I want to focus on here is what it had to say about the topic before us. Spengler's key conception was that for every part of mankind, in every epoch since Egypt, Greece, and Rome, the history of a civilization has taken fundamentally the same course, and this will continue in the future. Thus our own inevitable destiny in the West is to go to dust according to a timetable that he thought he could calculate from the available precedents. Spengler predicted the very date of our undoubted demise: the year 2000.

The end stages of every civilization, he wrote, can be recognized by the ideas science treasures in its own progress—by the adoption of the notion of causality instead of destiny; by attention to abstractions such as infinite space and to cause and effect, rather than to "living nature." The primacy of the soul is replaced by intellect; mathematics pervades more and more activities; and nature is reinterpreted as a network of laws within the corpus of what Spengler calls "scientific irreligion." Here Spengler introduces his most startling idea, one that has become familiar in new garb also. He warns that it is characteristic of the winter phase of civilization that precisely when high science is most fruitful within its own sphere, the seeds of its own undoing begin to sprout. This is so for two reasons: the authority of science fails both within and beyond its disciplinary limits; and an antithetical, self-destructive element arises inside the body of science itself that will eventually devour it.

The failure of science's authority outside its laboratories, he says, is due in good part to the tendency to overreach and misapply to the cosmos of history the thinking techniques that are appropriate only to the cosmos of nature. Spengler holds that the thought style of scientific analysis, namely "reason and cognition," fails in areas where one really needs the "habits of intuitive perception," of the sort he identifies with the Apollonian soul and the philosophy of Goethe. By asserting that an unbridgeable contrast exists between a pure "rationality" of abstract science and the intuitive life as lived, Spengler commits the same error as all such critics before him and after, to this day, of whom few seem even to have come closer to science than through their school textbooks. Therefore they are ignorant of the vast difference between, on the one hand, "public science"—the final results of intersubjective negotiations to fashion at least a temporary consensus and globalization on the basis of experiment and logic, and on the other hand, the earlier, "private" stage of work in science, where the particular researcher's intuitive, aesthetic, thematic or other non-logical preference may be the key to

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Ostwald, W. *Monism as the Goal of Civilization*. Hamburg, International Committee of Monism, 1913, 37.
The section that follows is an abstract of much of Chapter 5, "The Controversy over the End of Science," in Ref. 1.

the individual's advance beyond the previous level of public science. The complementarity between these two quite different stages in the actual development of any scientific result explains why in any given field the findings by natural scientists, operating within vastly different cultures and styles, are eventually harnessed into common products with (for a time) global validity.

All this may be clear enough to practicing scientists. But, Spengler continues, even in the cosmos of nature there is an attack on the authority of science, arising from within its own empire: Every conception is at bottom "anthropomorphic," and each culture incorporates this burden in the key conceptions and tests of its own science, which thereby become culturally conditioned illusions. All our rushing after positive scientific achievements in our century only hides the fact, he thinks, that as in classical times, science is once more destined to "fall on its own sword," and so will make way for a "second religiousness."

What Spengler termed the orgy of two centuries of exact sciences would shortly be ending, together with the rest of what was valuable in Western civilization. As a kind of postscript, Spengler added his opinion in his later book, (*Man and Technics* 1931), that advancing technology, with its mindlessly proliferating products, will also turn out to undermine the society of the West—because, he prophesied, its interest in and support of science and engineering will decrease: the "metaphysically exhausted" West will not maintain advances in these fields. Instead, the previously overexploited races in the rest of the world, "having caught up with their instructors," will surpass them and "forge a weapon against the heart of the Faustian [Western] Civilization." The non-Caucasian nations will adopt the technical skills, excel in them, and turn them against the Caucasian originators. In short, as H. Stuart Hughes put it, Spengler's prediction was that the East will triumph through better technology, first in commerce, and then militarily.⁶

A "scientific world conception" —the Vienna Circle

The early response to Spengler's diagnosis was predictably bimodal—on one side there was wide and enthusiastic acceptance, which continues among people today who have never read Spengler but, so to speak, have imbibed his ideas with their mother's milk. On the other side, the opponents of Spenglerian scenarios included of course many prominent scientists. Some of these had joined in a study group that called itself the Vienna Circle, which met in the 1920s and early '30s for discussion and publication. It included Moritz Schlick, Rudolf Carnap, Philipp Frank, Kurt Gödel, and Otto

Neurath. Among their active sympathizers, they could count Hans Reichenbach and Richard von Mises in Germany, and in America, B. F. Skinner, P. W. Bridgman, Charles Morris, and W. V. Quine.

The most influential publication of the core group was a slim pamphlet issued in October 1929 as a kind of manifesto of the movement, the main title being nothing less than *The Scientific Conception of the World*.⁷ The very title was a trumpet blast in the fight to change the balance again, to put science back at the center of modern culture, and against what the booklet called, in the first sentence, the chief alternative, the tendency toward metaphysical and theologizing thought, those old helpmates of the Romantic movement.

Although most of the scholars involved in the Vienna Circle concerned themselves chiefly with the study of the epistemological and logical problems at the foundations of science, there was a clear undercurrent of wider cultural, social, political, and pedagogic ambitions as well. For, as the manifesto said, "The attention toward questions of life is more closely related to the scientific world conception than it might at first glance appear. [...] For instance, endeavors toward the unification of mankind, toward a reform of school and education, all show an inner link with the scientific world conception. [...] We have to fashion intellectual tools for everyday life. [...] The vitality that shows itself in the efforts for a rational transformation of the social and economic order permeates the movement for a scientific world conception, too." (Carnap et al. 1929, 304–305.)

The members of the Circle associated themselves explicitly not with the Platonists and Pythagoreans, but with the Sophists and Epicureans, "with those who stand for earthly being, and the Here and Now." A science free from metaphysics would be a unified science; it would know no unsolvable riddles; it would train thinking to produce clear demarcations between meaningless and meaningful discourse, between intellect and emotion, between the areas of scientific scholarship on the one hand and myth on the other. Just as this approach would, by this formulation, clarify the foundations of mathematics, of the physical sciences, of biology and psychology, it would also demystify the foundations of the social sciences, "and in the first place [...] history and economics." The empiricist, antimetaphysical attitude would help to reject such dangerous conceptions as "folk spirit," and would "liberate from inhibiting prejudices."

Thus, the "debris of millennia" would be removed, and "a unified picture of this world" would emerge, free from magical beliefs. The social and economic struggles

⁶ Hughes, H. Stuart, and Oswald Spengler. *A Critical Estimate*. New York: Charles Scribner's Sons, 1952.

⁷ Carnap, Rudolf, Hans Hahn, and Otto Neurath. *Wissenschaftliche Weltanschauung: Der Wiener Kreis*. Vienna: Artur Wolf Verlag, 1929. For an English translation see Otto Neurath, *Empiricism and Sociology* (Dordrecht, Reidel, 1973). The page references are to the English translation; I have made occasional corrections in the translation, as necessary.

of the time would be ameliorated because the "broad masses of people" would reject the doctrines that have misled them. (Carnap et al., 315-317.) Beyond that, the spirit of the scientific world conception would penetrate "in growing measure the forms of personal and public life, in education, upbringing, architecture, and the shaping of economic and social life according to rational principles." And the manifesto for a new modernity ended with the blazing formulation, in italics: "The scientific world conception serves life, and life receives it" (Carnap et al., 318).

Perhaps the most carefully developed of the many publications expressing the Circle's position on science and its rationality as the keys to a sane world picture was the major book by Richard von Mises, the Austrian scientist, mathematician, engineer and philosopher (as well as scholar of the poet Rainer Maria Rilke). Von Mises entitled his big volume, with a bit of irony, *Kleines Lehrbuch des Positivismus*.⁸ The aim was not only to show what an empiricist-rational scientific world conception would consist of, what its tools would be, and what problems it could solve within the sciences, from mathematics and physics to biology and the social sciences. All this is done in great detail; but an equally motivating force was to present thereby a choice from the then-reigning alternatives in German-speaking Europe: the Kantianism in Germany and the clerical-metaphysical trend in Austria, both of which were then being interspersed with the growing totalitarian ideologies. Von Mises noted his quite explicit opposition to what he called "negativism," in which he includes systematic, philosophical, and political anti-intellectualisms that have remained part of the present landscape. Among the examples he cited were, in fact, Oswald Spengler, and the once-popular German philosopher Ludwig Klages, whose point of view was enshrined even in the title of his main work, *The Mind as Enemy of the Soul*.

As a sign that von Mises' main aim of the book was to put science at the center of a healthy culture in the largest meaning of the term, his volume dealt at length with the way the scientific world conception would illuminate the understanding of metaphysics, poetry, art, the law, and ethics. The underlying commonality of the various forms of cultural achievements was considered by von Mises to be due to the principal unity of their methods, if carried through rationally and soundly. The original readers of the book must have felt themselves to be in the presence of an updated follower of Auguste Comte. The very last sentence is, as it were, the summary of the whole project: "We expect from the future that to an ever-increasing extent scientific knowledge, i.e., knowledge formulated in a

connectable manner, will regulate life and the conduct of man." (Von Mises 1951, 370)⁹

Freud: Instinctual passions versus reasonable interests

But now we shall see the lever of sentiments shift the balance once more, and indeed on the very issue of whether knowledge formulated in a scientific manner can lead mankind to saner and more rational conduct. In 1929, the same year in which the optimistic manifesto of the Vienna Circle was published, Sigmund Freud, writing in the same city, produced a book of his mature years, giving his somber and pessimistic answer. To the founder of psychoanalysis, the role of science in our culture had been a continuing preoccupation, and in 1911 he had still been optimistic enough to sign the *Aufruf* of the Society for Positivistic Philosophy. But in that book of late 1929, *Das Unbehagen in der Kultur*,¹⁰ Freud found that science, while counting among the most visible manifestations of civilization, was at best an ameliorating influence in a titanic struggle on which the fate of our culture depended. That struggle, he said, was centered on mankind's often-doomed effort to master "the human instinct of aggression and self-destruction." Even at that time he saw, in the last paragraph of the book, that "Mankind has gained control over the forces of nature to such an extent that with their help it may have no difficulty to exterminate one another to the last man." (Freud 1929, 92.)

Freud held that the restrictions which civilization imposes upon the demands of our instincts produce an irremediable antagonism between those fetters versus the innate "Destructive Instinct," or "Death Instinct" (Freud 1929, 7, 8.), the drive that is constantly at odds with the civilizing project to elevate the moral condition of mankind. He wrote, "...man's natural aggressive instinct, the hostility of each against all, and of all against each, opposes this program of civilization. This aggressive instinct is the derivative and the main representative of the death instinct which we have found alongside of Eros, and which shares world-domination with it. And now, I think, the meaning of the evolution of civilization is no longer obscure to us. It must present the struggle between Eros and Death, between the instinct of life (*Lebenstrieb*) and the instinct of destruction (*Destruktionstrieb*), as it works itself out in the human species. This struggle is what all life essentially consists of, and the evolution of civilization may therefore be simply described as the struggle for life of the human species. And it is this battle of the giants that our nursemaids try to appease with their lullaby about Heaven." (Freud 1929, 69.)

⁸ He allowed a simpler title, *Positivism: A Study in Human Understanding*, for the English translation (Harvard University Press, 1951).

⁹ The word "control," used in the English edition, has been corrected to "regulate," which corresponds to the German edition.

¹⁰ Seriously mistranslated into English as *Civilization and its Discontents*. New York: W.W. Norton, 1961.

In this conflict, scientific and other cultural activities result from the successful if incomplete "sublimation of instinctual aims," making science at first glance merely a "vicissitude which has been forced upon the instincts by civilization." The accomplishments of science and technology originated as welcome tools in the effort to protect men against the hostile forces of nature; they have now become "cultural acquisitions" that "do not only sound like a fairy tale, they are actual fulfillments of every—or almost every—fairy tale wish." They verge on our attaining the old ideas of "omnipotence and omniscience." Man "has, as it were, become a kind of prosthetic God." (Freud 1929, 38-39.)

But there's the rub: Happiness still eludes him. "Present-day man does not feel happy in his God-like character," either individually or in terms of the group. That again has its reason in the fact that "civilization is built upon a renunciation of instinct," such as sexuality and aggressiveness, and "presupposes precisely the nonsatisfaction (by suppression, repression, or some other means) of powerful instincts." Hence, the "cultural frustration" (*Unbehagen*) which dominates the whole field of social relationships between human beings (Freud 1929, 43-44, 62).

Freud's pessimistic conclusion follows: "In consequence of this primary mutual hostility of human beings, civilized society is perpetually threatened with disintegration. The interest of work in common would not hold it together; instinctual passions are stronger than reasonable interests. [...] In spite of every effort these endeavors of civilization have not so far achieved very much. [...] It is always possible to bind together a considerable number of people in amity, so long as there are other people left to receive the manifestations of their aggressiveness," as in religious or ethnic persecution (Freud 1929, 59, 61).

During the decades since this was written, modern history has all too often seemed to be the experimental verification of Freud's dark assessments, according to which neither science nor any other cultural activity can fully displace our animal nature from its central position, but can only delay the ultimate fate that threatens.

Scientists as " betrayers of the truth"

Let us now turn to the more recent period. We are familiar with the fluctuations, during the 1960s and 1970s, of opinion in academe and among the public regarding the interactions of science and society. But starting in the early 1980s, a new and powerful element entered into this discussion, which has recently been assuming ever greater attention and institutionalization, at least in the US. The new element, the new force

adding to the derogation of the credibility of science, is the insistence from some quarters—which increasingly has fallen on receptive ears among the population—that to a previously completely unrealized degree the pursuit of science is, and has been all along, ever since the days of Hipparchus and Ptolemy, thoroughly corrupt and crooked. Consequently severe measures must be applied to the practice of science from outside. This assertion, which has become louder and louder over the past few years in books, official reports, and hundreds of articles, has spawned dramatic public hearings, the formation of specific government agencies, university bureaucracies, and quite a few careers. The safeguarding of ethical practices and uses of science, of which there has been a long tradition within the scientific community, is now to be put into better and wiser hands.

A striking, pace-setting example of this assertion was the book by two influential New York Times science editors, William Broad and Nicholas Wade. It states its intention in the title on the jacket, *Betrayers of the Truth: Fraud and Deceit in the Halls of Science*,¹¹ and follows up with the unqualified canon shot of the opening sentence: "This is a book about how science really works." Going far beyond the need to expose the relatively few rotten apples in any barrel, which the scientific community itself has long recognized as necessary, if only for the sake of its own health, this kind of rhetoric has become commonplace. As this book and its many followers proclaim, the relatively few, sad cases of real or alleged misbehavior are the litmus test for the whole enterprise. Fraud and deceit are depicted as being part of the very structure of scientific research.

Similarly, the report to Congress by the Congressional Research Service, entitled *Scientific Misconduct in Academia*, stated that, more and more, "the absence of empirical evidence which clearly indicates that misconduct in science is not a problem [...] suggests that significant misconduct remains a possibility." Among all the targets to preoccupy those who are charged with timely attention to misconduct damaging our republic, this formulation singles out the conduct of science as being guilty until proved innocent. Moreover, the tendency has recently been to include in the allegation of *scientific misconduct* not only falsification of data, plagiarism, and the like, but also the spectrum of misdeeds more common to flawed mankind generally, and for which sanctions have existed, e.g., "use of university resources for inappropriate purposes, sexual harassment, racial discrimination," etc.¹²

Similarly, the Office of Scientific Integrity Review (OSIR) of the Department of Health and Human Services made part of its proposed definition of

¹¹
New York: Simon & Schuster, 1982.

¹²
Science, 1993. Vol. 26: 1203.

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As reported in the *Washington Post*, March 20, 1992.

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Nature, January 6, 1994. Vol. 367: 6. Unlike most scientific journals in the US, *Nature* has been alert to the likely damage of the imbalance in reporting. See for example the editorial by John Maddox of March 17, 1994, in *Nature*, vol. 368: 185. It is noteworthy that another among the few who have spoken out against the growing tide of easy condemnation is also a trained science journalist, Barbara J. CULLITON, in her essay, "The Wrong Way to Handle Fraud in Science." *Cosmos*, 1994, 34–35. For an argument on the costs to science that may result from the excesses of distrust in science, see Steven SHAPIN, "Truth, Honesty, and Authority of Science," in the National Academy of Sciences report *Society's Choices: Social and Ethical Decision Making in Biomedicine* (Washington, DC, National Academy Press, 1994).

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The data were kindly furnished to me by Donald A. B. Lindberg, Director, National Library of Medicine. These cases are quite different from the laudable practice of scientists publishing correction notices when they find it necessary to draw attention to their own unintended errors. Eugene GARFIELD, "How to Avoid Spreading Error," *The Scientist*, 1: 9, 1987, reports that "of the 10 million journal items indexed in the SCI [Science Citation Index] since its inception, over 50,000 were coded as explicit corrections. [...] These vary from corrections of simple typographical errors to retractions of and outright apologies for 'bad' data or data that cannot be verified." This indicates a rate of 0.5 percent for such volunteered corrections of errors.

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In addition, the Office of Research Integrity of the US Public Health Service recently announced that starting about a year ago and looking back, it has found a total of 14 researchers guilty of some form of scientific misconduct out of about 55,000 researchers receiving PHS support per year. (Private communication of July 20, 1993, from Lyle W. Bivens, Acting Director, ORI.) The

"misconduct" in science, apart from fabrication, falsification, and plagiarism, "practices that seriously deviate from those that are commonly accepted in the scientific community." (Federal Code: 42 C.F.R. 50.102.) The intention here may have been to parallel the way the Supreme Court defined obscenity by reference to the current standards of the local community. However, when it comes to making progress in science, some practices contrary to those common at the time have again and again been the very hallmark of needed innovations—from putting mathematics into physics in the seventeenth century, to the introduction of quanta, which pained even the originator, Max Planck himself, and to the more recent innovation of modern teamwork. The proposed definition of misconduct, with its potential for mischief, was one more example of the gap between the culture of science and the culture outside the lab. One should add that to her credit the director of the National Institutes of Health at the time intervened on that point, objecting that such a community standard "would have implicated even the discoverer of penicillin, who serendipitously found good use for bacteria growing in a contaminated lab dish."¹³

The power of the generalized allegations against the conduct of science has two components. The first is of course the astonishing claim that basic research scientists in considerable numbers are intentionally false to their own most fundamental avowed mission, namely, to the pursuit of truths; in other words, that not just a few apples are rotten, but that the whole barrel is.

Yet, even in the presence of the occasional scandalous misdeeds by a relatively small number of the world's millions of scientific researchers, the vastly overblown allegation of pervasive and ingrained fraud and deceit in science would not have been taken so seriously that in the US the newspapers, college courses, training courses for scientists and physicians, commissions, Congressional committees, scientific societies, and so on, are now massively and expensively preoccupied with the institutionalization of the prevention of misconduct in science. The unrelenting accounts of specific incidents, some outrageous, more of them sensationalized, have left some of the public and legislators feeling that a great plague of dishonesty had invaded all academic laboratories. As the journal *Nature* noted shrewdly, the current trend is resulting in "a slow—and Hollywood-assisted—erosion of [the scientists'] public image, [...] [replacing it] in the public mind by a money-grabbing plagiarizing con-artist."¹⁴ *Time* magazine chimed in with an essay on scientists, beginning with, "Scientists, it seems, are becoming the new villains of Western society." A raft of best-selling books add up the allegations in diatribes that have the

frank aim, in the words of Bryan Appleyard's polemic *Understanding the Present: Science and the Soul of Man*, that science must be "humbled." We are, it appears, standing only on the shoulders of dwarfs.

What is getting lost in this avalanche of excitement, and also in the generally poor, even self-flagellating, responses from some scientific institutions, is some thorough inquiry into the actual rate of serious misconduct among scientists, the kind of empirical research that would yield a reasonable estimate of the likely relative rate of incidents. I have found only some scattered, preliminary steps in this direction, but these suggest that in fact the actual rate of misconduct (rather than suspected, alleged, or "perceived" without hard evidence) is remarkably low. Among the available, reasonably quantifiable measures is, for example, the National Library of Medicine finding that for the period of 1977 to 1986, when about 2,780,000 articles were published in the world's biomedical literature, 41 of these had to be withdrawn because fraudulent or falsified data appeared in them—a rate of under two one-thousandths of one percent of scientific publications per decade.¹⁵ Other data support the same point. Thus the Food and Drug Administration, responding to allegations or evidence of misconduct in clinical research with investigational new drugs research, submitted twenty cases of suspected fraud or other criminal violations to the US Attorney General's office. These resulted in thirteen convictions of clinical investigators—about one per year, on the average.¹⁶

Nobody does or should condone even a single case. But even if the actual rate were as much as a hundred times greater than these figures indicate, the intellectually most interesting questions would be, first, why science as a whole progresses so well despite being the work of mere human beings; second, how small the number of alleged misconduct is in this field compared with those in others, ranging from the world of finance, law, industry, journalism, and government at every level. And third, why the few cases of highly publicized charges of misconduct in science can so severely undermine the trust and confidence of the public and its representatives in the integrity of research in general.

Science as myth

The answer to those questions is in good part that there is indeed another, reinforcing reason for the widespread success of assaults on the credibility of scientific research. This second line of attack has been opened up by a loose assemblage made up of a branch of contemporary philosophy of science and other humanists, some of the so-called "strong-program" constructivist portion of sociology, of a small

subset of the media, of a small but growing number of governmental officials and political aspirants, and of a vocal segment of literary critics and political commentators associated with the avant-garde of the postmodern movement. This is a potent and eloquent collective of just the sort that in the past has successfully challenged the worldview of their time and place.

The overall message evolving from that direction is no longer based only on stories of unacceptable behavior among a few scientists. The charge has been generalized and made even more serious: Put in starker terms, the claim is that the most basic fraud committed by the members of the scientific community is their assertion *that there are any truths to be found at all*. For there really is nothing there even to betray and falsify; and consequently, science is inherently not corrigible, even if all misconduct were eliminated.

From that point of view, the business of science is mainly self-serving; for example, building and operating expensive institutions that claim to be looking for objectively ascertainable information about entities like quarks and bosons—which, however, are nothing more than "socially constructed" fictions. Against the naive realism that most scientists still embrace, and the agnosticism of the more sophisticated ones, the new critics counterpose the radical solution: as one sociologist of science put it recently, "There is no Nature; there is only a communication network among scientists." The literature in academe is now full of statements such as "science is a useful myth," or "we must abolish the distinction between science and fiction," or "science is politics by other means."¹⁷

Scientists have tended to adopt the Baconian view that the acquisition of basic knowledge of causes and interrelations of phenomena—by processes not easily predictable or fully understood—can yield power over those of nature's forces that cause our burdens and ills. But now, the new consortium tells us, the arrow really goes the other way: not from knowledge to power, but from power to knowledge, and to a rather questionable knowledge at that. The attempts to find generally applicable, shareable knowledge about what might be called reality—through the use of both the rational and the intuitive faculties of individual scientists, and through their skeptical but collaborative attempt to achieve some consensus—were not only doomed exercises, but ironically have led to the disasters that have marked the century. The whole modern era, launched under the flag of progress, has only led to tragedy. The extreme over-optimism of a Herbert Spencer or a Friedrich Engels can never be replaced by a soberer conception. Progress is illusion. The

cases involved work that ranged over a considerable period; for example, one of them began in 1977. To get a sense of the low yield of the allegations, and the pedestrian rather than sensational nature of most of the cases, see Office of Research Integrity, *Biennial Report 1991-92*, September 1993, US Dept. of Health and Human Services. To glimpse the enormous complexity, cost, and labor as well as the fragility of the process of adjudicating allegations of scientific misconduct, see for example the 63-page document, obtainable from the US Department of Health and Human Services, entitled: "Departmental Appeals Board. Research Integrity Adjudications Panel. Subject: Dr. Rameshwar K. Sharma, Docket No. A-93-50, Decision No. 1431, Date: August 6, 1993."

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For a scholarly and even-handed treatment of the spectrum of the varied interests of sociologists of science, see Zuckerman, Harriet. "The Sociology of Science" in Neil J. Smelser, ed., *Handbook of Sociology*. Beverly Hills, CA: Sage Publications, 1988, 511-574.

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For a thoughtful analysis, see Searle, John R. "Rationalism and Realism, What is at Stake?" *Daedalus*, 1993, no. 4, vol. 122: 55-83. A recent book that aims to answer the various types of critics is Gross, Paul R., and Norman Levitt. *Higher Superstition: The Academic Left and its Quarrels with Science*. Baltimore, MD: The Johns Hopkins Press, 1994. It is also useful for its extensive bibliography. Another stimulating resource is FARRELL, Frank B. *Subjectivity, Realism and Postmodernism*. New York: Cambridge University Press, 1994.

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Berlin, Isaiah. "The Crooked Timber of Humanity." *Chapters in the History of Ideas*. New York: Random House, 1992.

globalizing program of science—to find basic unities and harmony transcending the level of apparent variety and discord—is held to be completely contrary to the post-modern drive that celebrates individual variety and the equality of standing of every conceivable style and utterance, every group and competing interest. Ours is the time to face the end of the search for foundations, the "End of the Modern Era." We are in a state called the "objectivity crisis"—a fashionable phrase found in the titles of learned conferences and in policy-setting documents to be examined shortly.

Together, these slogans of the newly emerging sentiment indicate that the aim is not merely a call for the improvement of practice or for increased accountability, which is appropriate and being pursued through earnest actions, but at bottom is, for the main branch of the movement of critics, the delegitimation of science as one of the valid intellectual forces, a reshaping of the cultural balance, as we shall see in more detail below. In this respect, there is a big difference here compared with the history of *internal* movements of protest, such as those of the logical positivists within philosophy, the Impressionists or Dadaists within art, the modern composers within music, etc. In all those cases, it was some of the best talent in the field that took up the task of renewal. Not so here—the motivating force is not renewal from within, but radical cultural politics from without.¹⁸

The Romantic Movement's challenge

Here we meet a clarifying fact: the contest before us is not new, but draws on historic forces of great strength and durability. Therefore it will be instructive to trace some of the individual steps and stages in this remarkable development of the growing new view, so as to make it easier to extrapolate and to preview the new terrain we may have before us. While I can here only point briefly to a few recent milestones, I shall seek documentation in the recent writings of some of the most distinguished thinkers, rather than, say, through representatives of the Dionysian undercurrent.

Our first informant and guide is Isaiah Berlin, widely regarded as a most sensitive and humane historian of ideas. The collection of his essays, published as the fifth volume of his collected papers,¹⁹ opens with a startling dichotomy. He writes: "There are, in my view, two factors that, above all others, have shaped human history in this [the twentieth] century. One is the development of the natural sciences and technology, certainly the greatest success story of our time—to this great and mounting attention has been paid from all quarters. The other, without doubt, consists of the great ideological storms that have altered the lives of

virtually all mankind: the Russian revolution and its aftermath—totalitarian tyrannies of both right and left and the explosion of nationalism, racism and, in places, of religious bigotry, which, interestingly enough, not one among the most perceptive social thinkers of the nineteenth century had ever predicted." (Berlin, 1991, 1.) He adds that if mankind survives, in two or three centuries' time these two phenomena will "be held to be the outstanding characteristics of our century, the most demanding of explanation and analysis."

What might the author intend by so juxtaposing these two "great movements"? One's first temptation may be to see a connection through the fact that during World War II the ingenuity and frantic work of scientists among the Allies, supporting the valor of the Allied soldiers, brought an end to the totalitarian tyranny of that period, which might well have triumphed over the democracies and established itself at least throughout Europe.

But such a response would not be to the point here. What is on Isaiah Berlin's mind is quite different. As we follow his eloquent and subtle analysis, it dawns on the reader that science and tyranny, the two polar opposite movements which he holds to have defined and shaped the history of this century, are somehow intertwined—that the development of the modern natural sciences and technology may, *through the reactions against them*, have unintentionally and indirectly contributed to the rise of those "totalitarian tyrannies."

This stunning connection, to be sure, is never explicitly spelled out by the author. But we can glimpse the implicit argument later in the book, in his chapter significantly entitled "The Apotheosis of the Romantic Will: The Revolt against the Myth of an Ideal World." There, Berlin summarizes the chronology of some basic concepts and categories in the Western world, specifically the changes in "secular values, ideals, goals." What commands his attention is the change away from the belief in the "central core of the intellectual tradition [...] since Plato," and toward a "deep and radical revolt against the central tradition of Western thought" (Berlin, 1991, 208), a revolt which in recent times has been trying to wrench Western consciousness into a new path.

The central core of the old belief system, one that lasted into the twentieth century, rested on three dogmas that the author summarized roughly as follows. The first is that "to all genuine questions there is one true answer, all others being false, and this applies equally to questions of conduct and feeling, to questions of theory and observation, to questions of value no less than to those of fact." The second dogma is that, "The true answers to such questions

are in principle knowable." And the third: "These true answers cannot clash with one another." They cannot be incommensurate, but "must form a harmonious whole," the wholeness being assured by either the internal logic among or the complete compatibility of the elements. (Berlin 1991, 209-211.)

Out of these three ancient dogmas both institutionalized religions and the sciences developed to their present form (although one might add that modern scientists, in their practice, have become aware of the need for proceeding antidogmatically, by conjecture, test, refutation, and assaying probability). In their pure state, these systems are utopian in principle, for they are imbued by the optimistic belief, inherent in and derivable from the dogmas, that "a life formed according to the true answers would constitute the ideal society, the golden age." All utopias, Isaiah Berlin reminds us, are "based upon the discoverability and harmony of objectively true ends, true for all men, at all times and places"—and by implication the same is true for scientific and technical progress, which are aspects of our drive toward what he calls "a total solution: that in the fullness of time, whether by the will of God or by human effort, the reign of irrationality, injustice, and misery will end; man will be liberated, and will no longer be the plaything of forces beyond his control [such as] savage nature...." This is the common ground shared by Epicurus and Marx, Bacon and Condorcet, the Communist Manifesto, the modern technocrats, and the "seekers after alternative societies." (Berlin 1991, 212-123.)

But, Isaiah Berlin now explains, this prominent component of the modern world picture is precisely what was rejected in a revolt by a two-centuries-old counter movement that has been termed Romanticism or the Romantic Rebellion. From its start in the German *Sturm and Drang* movement of the end of the eighteenth century, it grew rapidly in Western civilization, vowing to replace the ideals of the optimistic program, based on rationality and objectively true ends, by the "enthronement of the will of individuals or classes, [with] the rejection of reason and order as being prison houses of the spirit."

My own favorite summary of the view of science and its disvalue in nineteenth-century literature is the anti-hero in Ivan Turgenev's gripping novel, *Fathers and Sons*. One of the greatest figures of Russian literature, together with Gogol, Dostoevski, and Tolstoy, Turgenev was a poet largely in the tradition of nineteenth-century Romanticism, inspired by Goethe, Schiller, and Byron, among others. *Fathers and Sons* was published in 1861. Its main figure is Yevgeny Vassilevich Bazarov, a university student of the natural sciences, expecting to

get his degree as a physician shortly. Being a scientist who "examines everything from a critical point of view," he confesses himself also to be ideologically and politically a nihilist, the natural consequence of not acknowledging any external authority. All talk of love, or the "mystic relationship between a man and a woman," is to him just "romanticism, humbug, rot, art." It would be better to study the behavior of beetles. Even on his vacation he has brought along a microscope and fusses over it "for hours at a time." Reading Pushkin, he says, is for little boys. He thinks it would be much better to start with Ludwig Büchner's *Force and Matter*, a book published in 1855 and embodying such a flagrantly materialistic view that Büchner was forced to resign from his professorship in Germany. (It is, as it turned out later, the very book Albert Einstein singled out in his *Autobiographical Notes* as one of the two or three that most impressed him as a boy, and caused him to turn to the pursuit of science.)

What matters, Bazarov claims, "is that two and two are four—all the rest is nonsense." When he meets a clever and beautiful woman, he startles his friend by saying that hers would be a beautiful body to examine—on a dissection table. As if in revenge, fate brings him to the bedside of a villager dying of typhus, and he is made to help in the postmortem. But he cuts himself with his scalpel, and soon he is on the verge of delirium, a case of surgical poisoning. As he is dying, he tries to keep hold on his kind of reality by asking himself aloud, "Now, what is 8 minus 10?" In short, he is a caricature recognizable throughout literature—except that the figure of the emotionally dysfunctional scientist, from Dr. Frankenstein to the crew of Dr. Strangelove, causes surgical sepsis not only in each of them, but also in all those around them.

Returning to Isaiah Berlin's account, it is striking that, as he notes, no one predicted that a form of the worldwide Romantic Rebellion would be what dominated "the last third of the twentieth century." The Enlightenment's search for generalizability and rational order is depicted by the rebels of our time as leading at best to the pathetic Bazarovs of science, and those must be replaced by the celebration of the individual, by flamboyant antirationalism, by "resistance to external force, social or natural." In the words of Johann Gottfried von Herder, the rebel shouts: "I am not here to think, but to be, feel, live!" (Berlin, 1991, 223.) Truth, authority and nobility come from having heroically suffered victimization.

This assertion of the individual will over sharable reason has undermined what Isaiah Berlin had called the three pillars of the main Western tradition. The Romantic Rebellion of course has also given us

enduring masterpieces of art, music, and literature. But it originated, as it were, as an antithetical mirror image, created in reaction to the very existence of the earlier Enlightenment-based conception. In the apotheosis of the Romantic Will in our time, it glows forth as the alternative, the "romantic self-assertion, nationalism, the worship of heroes, and leaders, and in the end [...] Fascism and brutal irrationalism and the oppression of minorities." (Berlin, 1991, 225.) Moreover, in the absence of "objective rules," the new rules are those that the rebels themselves make: "Ends are not [...] objective values. [...] Ends are not discovered at all but made; not found but created."

As a result, "this war upon the objective world, upon the very notion of objectivity," launched by philosophers and also through novels and plays, infected the modern worldview. The "romantics have dealt a fatal blow" to the earlier certainties, and have "permanently shaken the faith in universal, objective truth in matters of conduct" (Berlin, 1991, 236-237)—and, he might have added, in science as well. As any revolt does, this one puts before us seemingly mutually incompatible choices. Just as with quite antithetical cases of excess such as Ostwald's, it is again either/or, rather than the needed complementarity of mankind's rational, passionate, and spiritual functions. One is reminded here of the fact that extremes tend to meet each other. Thus the poet William Blake, the epitome of the Romantic Rebellion—who called the work of Bacon, Newton, and Locke satanic—composed in his *The Marriage of Heaven and Hell* (1790) one of the "Proverbs" that reveal the credo of so many of the opposing actors in this story to this day: "*The road of excess leads to the palace of wisdom.*"

The Romantic Rebellion infuses state policy

Other authors provide verification and elaboration of the implications of Berlin's findings, and especially so of the ominous joining of the extremes of a Romantic Rebellion with irrational political doctrines. This was evident in the "Cultural Revolution" in Mao's China, in the USSR, and in other totalitarian systems. To glance at least at one telling example, the historian Fritz Stern has written about the early phases of growth of Nazism in Germany when there arose in the 1920s, in his words, the "cultural Luddites, who in their resentment of modernity sought to smash the whole machinery of culture." The fury over an essential part of the program of modernity, "the growing power of liberalism and secularism," directed itself naturally also against science itself. Julius Langbehn was one of the most widely read German ideologues in the 1920s, and Stern writes of him, "Hatred of science dominated all of Langbehn's

thought. [...] To Langbehn, science signified positivism, rationalism, empiricism, mechanistic materialism, technology, skepticism, dogmatism, and specialization..."

Long before the Nazis assumed governmental power, some German scientists and other scholars demanded that a new science be created to take the place of the old one, which they discredited—a new "Aryan science," based on intuitive concepts rather than those derived from theory; on the ether, the presumed residence of the "Geist;" on the refusal to accept formalistic or abstract conceptions, which were reviled as earmarks of "Jewish science;" and on the adoption as far as possible of basic advances "made by Germans."

In a classic study,²⁰ Alan Beyerchen identified some of the other main pillars of Aryan science. There we find themes uncomfortably similar to those that are again fashionable. A prominent part of Aryan science was, of course, that science, as some would now say, is basically a social construct, so that the racial heritage of the observer "directly affected the perspective of his work." Scientists of undesirable races, therefore, could not qualify; rather, one had to listen only to those who were in harmony with the masses, the "Volk." Moreover, this *völkisch* outlook encouraged the use of ideologically screened non-experts to participate in judgments on technical matters (as in the *Volksgerichte*). The international character of the consensus mechanism for finding agreement was also abhorrent to the Nazi ideologues. Mechanistic materialism, denounced as the foundation of Marxism, was to be purged from science, and physics was to be reinterpreted to be connected not with the matter but with the spirit. "The Aryan physics adherents thus ruled out objectivity and internationality in science. [...] Objectivity in science was merely a slogan invented by professors to protect their interests." Hermann Rauschning, president of the Danzig Senate, quoted Adolf Hitler as follows:

We stand at the end of the Age of Reason. [...] A new era of the magical explanation of the world is rising, an explanation based on will rather than knowledge: There is no truth, in either the moral or the scientific sense. [...] Science is a social phenomenon, and like all those, is limited by the usefulness or harm it causes. With the slogan of objective science the Professoriat only wanted to free itself from the very necessary supervision by the State.

That which is called the crisis of science is nothing more than the gentlemen are beginning to see on their own how they have gotten onto the wrong track with their objectivity and autonomy. A simple question that precedes every scientific enterprise is: Who is it who wants to know something, who is it who wants to orient himself in the world around him?²¹

One issue was how technology, so useful to the state, could be fitted into the Romantic idea. In recent times, many antimodern movements, including Fundamentalist ones, have embraced technology. But Philipp Lenard, an outstanding physicist but a chief cultural hero of Nazi propaganda, spoke for at least a minority when he said that the tendency of scientific results to prepare the ground for practical advances has led to a dangerous notion, that of man's "mastery" of nature: Such an attitude, he held, only revealed the influence of "spiritually impoverished grand technicians" and their "all-undermining alien spirit." This idea, too, had its roots in the centuries-old history of the rise of Romantic thought. Alan Beyerchen summarizes this section with the observation that "the romantic rejection of mechanistic materialism, rationalism, theory and abstraction, objectivity, and specialization had long been linked with beliefs in an organic universe, with stress on mystery [and] subjectivity..."

Because all these excesses were couched in phrases so reminiscent of currently used ones to delegitimize the intellectual authority of science, it is necessary to keep in mind that there is only a common ancestry of these views, rather than a necessarily causal connection between them. This applies also to the next case, as I turn now to the position embraced by another distinguished contemporary icon among humanists, although an advocate rather than an analyst. His writings on this topic are—like those of Oswald Spengler, or the positivists—of interest here not because they represent majority positions, which they do not, but because they have the potential for wide resonance at a turning point of sentiments. Also, in this case we shall see that the relation between modern natural science and the rise of totalitarianism, which Isaiah Berlin considered to be only the result of an obscene historic counterreaction, now receives a much more sinister interpretation: the two become directly, causally linked.

This ominous linkage has been argued repeatedly in writings by the Czech poet, playwright, resistance fighter against Marxist-Leninist oppression, and statesman—Václav Havel. In the passages to be discussed, we will notice that he subscribes to many of the themes discussed in Isaiah Berlin's analysis; but Havel's key point is that totalitarianism in our time was simply the perverse extreme end result of a trend of ideas embodied in the program of science itself. In this sense, Western science gave birth to Communism; and with the fall of the latter, the former has also been irremediably compromised.

Looking back on the twentieth century, other Central Europeans might characterize it as the release of the forces of brutal irrationality and bestiality, a reversion to

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Beyerchen, Alan. *Scientists under Hitler: Politics and the Physics Community in the Third Reich*. New Haven, CT: Yale University Press, 1977.

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Rauschning, Hermann. *Gespräche mit Hitler*. New York, Europa Verlag, 1940, 210. Mussolini expressed himself similarly.

ruthless autocracies in which the fates of millions were sealed by the whims of Kaiser Wilhelm, Hitler, Stalin, and their henchmen—rather than being the offspring of organized skepticism and the search for reasoned consensus, which are at the heart of science. But Havel finds the chief sources of trouble in that century to have been the very opposite, namely, the habit—in his words—of “rational, cognitive thinking,” “depersonalized objectivity,” and “the cult of objectivity.” He advises us to take refuge now in unrepeatable personal experience, in intuition and mystery, and the other mainstays of the Romantic Rebellion. I must let him put his case at some length in his own words; for while he eschews the documentation or balanced account of the scholar, he is instead in fine command of the rhetoric of persuasion, the ease of unspecified assertions and generalizations, and of the chief art of the dramatist, the suspension of disbelief. The result, for many of his readers, is hypnotic acquiescence without questioning the generalities and leaps in the prose. The “end of Communism,” he writes in one of his most widely quoted essays,

...has brought an end not just to the 19th and 20th centuries, but to the modern age as a whole.

The modern era has been dominated by the culminating belief, expressed in different forms, that the world—and Being as such—is a wholly knowable system governed by a finite number of universal laws that man can grasp and rationally direct for his own benefit. This era, beginning in the Renaissance and developing from the Enlightenment to socialism, from positivism to scientism, from the Industrial Revolution to the information revolution, was characterized by rapid advances in rational, cognitive thinking. This, in turn, gave rise to the proud belief that man, as the pinnacle of everything that exists, was capable of objectively describing, explaining and controlling everything that exists, and of possessing the one and only truth about the world. It was an era in which there was a cult of depersonalized objectivity, an era in which objective knowledge was amassed and technologically exploited, an era of systems, institutions, mechanisms and statistical averages. It was an era of freely transferable, existentially ungrounded information. It was an era of ideologies, doctrines, interpretations of reality, an era in which the goal was to find a universal theory of the world, and thus a universal key to unlock its prosperity.

Communism was the perverse extreme of this trend. [...] The fall of Communism can be regarded as a sign that modern thought—based on the premise that the world is objectively knowable, and that the knowledge so obtained can be absolutely generalized—has come to a final crisis. This era has created the first global, or planetary, technical civilization, but it has reached the limit of its potential, the point beyond which the abyss begins.

Traditional science, with its usual coolness, can describe the different ways we might destroy ourselves, but it cannot offer truly effective and practicable instructions on how to avert them.²²

²² “Politics and the World Itself,” *Kettering Review*, Summer 1992, 9–11. His essay was also printed on March 1, 1992, in the *New York Times* as Havel’s OpEd, entitled “The End of the Modern Era.”

²³ Graham, Loren R. *The Ghost of the Executed Engineer: Technology and the Fall of the Soviet Union*. Cambridge, MA: Harvard University Press, 1993.

A listener might at this point begin by objecting that these passages are built on immense over-generalizations and illogical jumps, just as flawed as those of the extreme Monists were on the other side; or that at least on factual grounds the self-designation of Communist ideology as “scientific” was indeed a fraud. On this last point, the scholar of the history and philosophy of Soviet science, Loren Graham, made the trenchant observation: “In 1992, the playwright and President of independent Czechoslovakia, Václav Havel, wrote that the fall of communism marked the end of an era, the demise of thought based on scientific objectivity. [...] Was the building of the White Sea Canal in the wrong place and by the most primitive methods, at the cost of hundreds of thousands of prisoners’ lives, the blossoming of rationality? Was the disregard of the best technical specialists’ advice in the construction of Magnitogorsk, the Dnieper dam and the Baikal-Amur Railway a similar victory for objectivity? Was the education of the largest army of engineers the world has ever seen—people who would come to rule the entire Soviet bureaucracy—in such a way that they knew almost nothing of modern economics and politics an achievement of science? [...] And even long after the death of Stalin, into the 1980s, what was the Soviet insistence on maintaining inefficient state farms and giant state factories, if not an expression of willful dogmatism that flew in the face of a mountain of empirical data?”²³

But one may doubt if Havel would reconsider his position, for the object of his essay is the conclusion, presenting the “way out of the crisis of objectivism,” as Havel labels it. Only a radical change in man’s attitude toward the world will serve. Instead of the generalizing and objectifying methods that yield shareable, repeatable, inter- or trans-subjective explanations, we must now turn, he says, to the very opposite, which presumably “science” somehow has totally banished from this world, i.e., to “such forces as a natural, unique, and unrepeatable experience of the world, an elementary sense of justice, the ability to see things as others do, [...] courage, compassion, and faith in the importance of particular measures that do not aspire to be a universal key to salvation. [...] We must see the pluralism of the world. [...] We must try harder to understand than to explain.” Man needs “...individual spirituality, firsthand personal insight into things [...] and above all trust in his own subjectivity as his principal link with the subjectivity of the world...”

Despite Havel’s hint, in passing, of a possible blending of the “construction of universal systemic solutions” or “scientific representation and analysis” with the authority of “personal experience,” so as to achieve a

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Reprinted in Vladislav, Jan, ed. *Vaclav Havel, or Living in the Truth*. London: Faber & Faber, 1987, 138–39. The passage was written in 1984.

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On July 4, 1994 Havel used the occasion to repeat at length much of his previous argument, in the service of explaining the present "state of mind [that] is called postmodernism," and the "crisis" to which science has led mankind. The only new part of his speech (published as an OpEd, July 8, 1994, *New York Times*) is that our "lost integrity" might paradoxically be renewed by "a science that is new, postmodern," such as the "anthropic cosmological principle" and "the Gaia hypothesis." This was too much even for Nicholas Wade, who wrote a devastating attack on Havel's essay (WADE, N. "Method and Madness: A Fable for Fleas." *New York Times Magazine*, August 14, 1994, 18), ending with: "A view of the world built on the anthropic principle and the Gaia hypothesis would not be postmodern science but rather a throwback to the numerology and astrology from which the era of rationalism has still not fully rescued us. [...] To subvert rationalism into mysticism would be a cure more pernicious than the disease." The seduction of being counted among the postmoderns has apparently attracted even a handful of scientists; the chief example given is their postmodernist interest in "the limits of science." However, the lively discussion of that topic began in the 1870s, led by Emile Dubois-Reymond, and it also preoccupied the logical positivists. For other examples of this old problem, see HOLTON, G. and R. S. MORISON, eds. *Limits of Scientific Inquiry*. New York: W. W. Norton, 1978.

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Published in September 1992 in the *American Journal of Physics*. Vol. 60, no. 9: 779–781.

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Tape recording of the session (February 12, 1993) obtainable from the American Association for the Advancement of Science. George Brown's own "Opening Remarks" were also distributed as a Press Release by his Washington, DC office.

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At the February 12, 1993, American Association for the Advancement of Science annual meeting.

"new, postmodern face" for politics, Havel's identification of the "End of the Modern Era" is not to be understood merely as a plea for some compromise or coexistence among the rival constructs; that much was announced in an earlier and even sharper version of his essay, one which dealt with the place of modern science quite unambiguously and hence deserves careful reading:

[Ours is] an epoch which denies the binding importance of personal experience—including the experience of mystery and of the absolute—and displaces the personally experienced absolute as the measure of the world with a new, manmade absolute, devoid of mystery, free of the 'whims' of subjectivity and, as such, impersonal and inhuman. It is the absolute of so-called objectivity: the objective, rational cognition of the scientific model of the world.

Modern science, constructing its universally valid image of the world, thus crashes through the bounds of the natural world, which it can understand only as a prison of prejudices from which we must break out into the light of objectively verified truth. [...] With that, of course, it abolishes as mere fiction even the innermost foundation of our natural world. It kills God and takes his place on the vacant throne, so that henceforth it would be science that would hold the order of being in its hand as its sole legitimate guardian and be the sole legitimate arbiter of all relevant truth. For after all, it is only science that rises above all individual subjective truths and replaces them with a superior, trans-subjective, trans-personal truth which is truly objective and universal.

Modern rationalism and modern science, through the work of man that, as all human works, developed within our natural world, now systematically leave it behind, deny it, degrade and defame it—and, of course, at the same time colonize it.²⁴

Here we see the giant step that Havel has taken beyond Berlin's analysis: It is modern science itself that has been the fatal agent of the modern era. As if to answer Ostwald's excesses, it is held responsible even for deicide.

Many have been moved by Havel's powerful mixture of poetical feeling, theatrical flourish, and the bold waving of an ancient, bloodstained shirt. The summary of his ideas, published conspicuously under the title "The End of the Modern Era,"²⁵ made an immediate and uncritical impression on readers of the most varied backgrounds. Among them was one person especially well placed to ponder the values of science, and to draw conclusions of great import for the life of science in the US. Here we arrive at the last of the stages on the road to the current understanding of the place of science in our culture.

The person so deeply affected by Havel's piece was none other than the distinguished chairman of the US Congress Committee on Science, Space, and Technology, and one of the staunchest and most effective advocates of science during his long tenure in the House of

Representatives: George E. Brown, Jr. of California. He acknowledged that he had received "inspiration" from Havel's essay, "The End of the Modern Era," and decided to reconsider his role as a public advocate of science. He therefore first wrote a long and introspective essay²⁶ under the title "The Objectivity Crisis," and then presented it to a group of social scientists in a public session at the annual meeting of the American Association for the Advancement of Science, under the title "The Objectivity Crisis: Rethinking the Role of Science in Society."²⁷

Persuaded by Havel's version of the Romantic Revolt, Brown cast about earnestly for the consequences it should have for the pursuit of science in his country. As a pragmatic political leader, he was primarily concerned with how scientific activity may hold on to some legitimacy—by service to the nation in terms of visible "sustainable advances in the quality of life," "the desire to achieve justice" (which he says "is considered outside the realm of scientific considerations"), and all the other "real, subjective problems that face mankind." He now saw little evidence that "objective scientific knowledge leads to subjective benefits for humanity." The privileging of the claim of unfettered basic research is void too, he said, because all research choices are "contextual" and subject to the "momentum of history."

Moreover, science has usurped primacy "over other types of cognition and experience." Here Brown quoted Havel's definition of the "crisis of objectivity" being the result of the alleged subjugation of our subjective humanity, our "sense of justice, [...] archetypal wisdom, good taste, courage, compassion, and faith," the processes of science "not only cannot help us distinguish between good and bad, but strongly assert that its results are, and should be, value free." In sum, Brown held, it would be all too easy to support more research when the proper solution is instead "to change ourselves." Indeed, he came to the conclusion that "the promise of science may be at the root of our problems." To be sure, the energies of scientists might still find use if they were properly directed, chiefly into the field of education or into work toward "specific goals that define an overall context for research," such as population control. Embracing a form of Baconianism, Brown thus rejected Vannevar Bush's more general vision for science, a rejection I quoted near the beginning of this essay (see note 2). Like Havel's, his answer to the question whether science can share a place at the center of modern culture was clearly No.

When George Brown presented his ideas to an audience of scientists at the session he had organized and for which he had selected a panel of social scientists,²⁸ only one of the panel allowed himself to disagree openly, while another of the panelists urged

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Brown, George E. "New Ways of Looking at US Science and Technology." *Physics Today*, 1994. Vol. 47: 32. In a talk on "The Roles and Responsibilities of Science in Post-modern Culture" (February 20, 1994, at another annual meeting of the American Association for the Advancement of Science), Mr. Brown remarked: "Let me begin by suggesting that the term 'post-modern culture,' sometimes used to describe the present era, is a rubric that comes from the arts and architecture where it had identifiable meaning. To my mind, if the term post-modern is used as a definitional period for policy, politics, or for economic eras, it leads to confusion; and it will not help us to define a point of departure for our discussion here. I hope today's discourse does not get sidetracked on a tedious dissection of post-modernism. I should note, however, that the editorial that appeared in the *New York Times* two years ago entitled 'The End of the Modern Era' by Czech philosopher and playwright Václav Havel, contained several points to which I agree, and have included in previous talks. Although Havel comes to the terms modernism and postmodernism from his artistic and philosophical orientation, I do not subscribe to those labels, in large part because I do not fully understand his use of them." Similarly, Mr. Brown is one of the few policy makers who has protested Senator Barbara Mikulski's recent edict that federal funding for basic, "curiosity-driven" research be cut back in favor of supposedly quick-payoff "strategic research."

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See especially Brooks, Harvey. "Research Universities and the Social Contract for Science," in Lewis Branscomb, ed., *Empowering Technology: Implementing a US Strategy* (Cambridge, MA: MIT Press, 1993). Brooks has all along been one of the most prescient and observant authors on the place of science in our culture. See for example his essay, "Can Science Survive in the Modern Age?" *Science*, 1971. Vol. 174: 21–30.

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E.g., in Price, Don K. "Purists and Politicians." *Science*, Jan. 3, 1969. Vol. 163: 25–31.

Brown to go even further still: Perhaps not realizing how close he was coming to the "*völkische*" solution tried earlier elsewhere, including in Mao's Cultural Revolution, he seriously suggested that to screen proposals for scientific research funding the federal government form a variation of the National Science Foundation's Board whose membership should contain such non-experts as "a homeless person [and] a member of an urban gang." No one there dared to raise an audible objection. One felt as if one glimpsed the shape of a possible future. But it is also important to note that later on Mr. Brown, apparently moved by the intellectual objections, such as those given above, voiced to him by one or two scientists, distanced himself from Havel's position. Indeed, no one can fail to agree with him that in the post-Cold-War context, it is "a moral imperative to enlist science and technology in a campaign for a more productive and humane society in which all Americans can enjoy the benefits of an improved quality of life."²⁹

In this brief overview, ranging from the trembling pillars of the Platonic tradition of the West to the so-called "End of the Modern Era" and the "End of Progress," we have identified some of the chief historic trends that have risen and fallen and risen again in the mixture from which the predominant view of an epoch emerges. Today's version of the Romantic Rebellion, while strong in other fields, represents still only a seductive minority view among analysts and science policy makers, coming not up from the grass roots but down from the treetops. However, while it is held among prominent persons who can indeed influence the direction of a cultural shift, the scientists at large, and especially the scientific establishment, have chosen to respond so far mostly with quiet acquiescence. If those trends should continue, and the self-designated postmodernists rise to controlling force, the new sensibility in the era to come will be very different indeed from the recently dominant one.

Experts in science policy are now debating what they call the on-going renegotiation of the "social

contract" between science and society.³⁰ One can argue that such a change has been overdue for many reasons, one being that the relatively protected position given to science for many decades had less to do with society's commitment than with the Cold War and with the implicit over-promises regarding spin-offs, which, as Don K. Price warned long ago,³¹ would eventually come back to haunt scientists. Adding concerns about the state of the economy, and competitiveness, the lack of general scientific literacy, etc., there is much in such a list to help explain the public's readiness for a reappraisal. But by my analysis, such factors act only as catalysts or facilitators of the tidal change that historically are always potentially present in our culture.

Of course, it may turn out that the recent version of the Romantic Rebellion will peter out—although I doubt it will. Or it may gain strength, as it did in the nineteenth-century and again at various times in the twentieth, especially when the scientific community itself paid little attention to the course of events. Or at best a new accommodation might gradually emerge, a "third way," based on a concept analogous to complementarity (and also analogous to the complementarity of personal and public science within the practice of research itself). That is, it may at last be more widely recognized, by intellectuals and the masses alike, that the scientific and humanistic aspects of our culture do not have to be opposing worldviews that must compete for exclusive dominance, but are in fact complementary aspects of our humanity that can and do coexist productively (as Samuel Taylor Coleridge put it memorably in chapter 14 of his *Biographia Literaria*: "in the balance or reconciliation of opposite or discordant qualities"). At any rate, historians will watch the next stages of the old struggle to define the place of science in our culture with undiminished fascination—although perhaps also with an uneasy recollection of Oswald Spengler's prophecy, of Sigmund Freud's pessimism, and of Isaiah Berlin's analysis of the trajectory of our modern era.