For many years I have begun my law and science seminar by asking the students to write down the name of the most brilliant person who ever lived. I instruct them to write the first name that comes to mind using whatever definition of brilliance they like. I then collect their responses and read them aloud. They always fall into the same categories. Scientists predominate, led by Einstein and Newton, but Shakespeare and Mozart do rather well too. There is often a smattering of support for da Vinci, and I have seen occasional votes for Plato, Freud, and many others. There is one thing, however, of which I can be absolutely sure: No one ever names a lawyer—no Brandeis, no Mansfield, no Holmes, no Cardozo. My students are all in law school, so it cannot be from a lack of familiarity with great lawyers and jurists. Nor is this result limited to law students. I have asked the same question of scientists, musicians, and others, and the result is always the same. No one ever names a lawyer.

Having read aloud their responses, I ask the students why scientists are often thought to be brilliant but lawyers rarely are considered so. A few possibilities are quickly eliminated. It cannot be that there is one continuum of intelligence on which scientists rank higher. If that were so, a great scientist would inevitably make a great lawyer or judge—a proposition few are ready to support. Indeed, the occasional forays of scientists into other disciplines make it clear that for some, scientific ability implies very little about ability in other fields. Isaac Newton’s historical writings, for example, are something of an embarrassment to his admirers. Thus the biographer Edward Andrade, who regards New-
ton as "one of the greatest names in the history of human thought," says of Newton's *Chronology of the Ancient Kingdoms Amended*, "I am afraid no one reads it nowadays or would take it very seriously if they did. Newton thought that he could not be more than twenty years wrong with any of his dates: modern opinion is that he was often wrong by centuries."²

Nor can it be that a scientist's contributions are more individualistic or unique than a lawyer's. On the contrary, an important feature of the history of science is the prevalence of simultaneous independent discovery. If one scientist had not made a breakthrough, often another would have, if not right away then perhaps within a decade or two. Einstein agreed with historians of science that the special theory of relativity was very much in the air among scientists at the beginning of the twentieth century; on the other hand, the role of the U.S Supreme Court was arguably shaped in a fundamental way by Chief Justice John Marshall in the early nineteenth century.³

*Progress in Science*

To explain the results I encounter when I take my survey, we look not at the intelligence quotient of scientists and lawyers, but rather at the nature of science and law. Scientists are most often thought of as brilliant because science appears unambiguously to make progress. It may be a truisim to say that scientists today know more than scientists in the past, but it is a truisim with important implications. An assistant professor of biology today may know more about evolution than Darwin. That does not mean the professor is brighter than Darwin, but only that the professor stands on Darwin's shoulders and on the shoulders of many other scientists. Because science is in this sense cumulative, it is possible to say that a particular scientist has made an important contribution. Scientists achieve this consensus on progress largely by adhering to a standard of testability for evaluating theories. A scientist can come up with a hypothesis about the natural world through any process at all—systematic study, inspired speculation, or fevered dreams. But that hypothesis must ultimately be subject to controlled tests, reproducible by others. A new hypothesis that stands up to testing and explains important matters not previously understood will eventually be accepted by other scientists. Thus, a side effect of this emphasis on progress is an
emphasis on priority— the one who first makes a discovery is the one to be rewarded. The result is a community in which outstanding achievement—brilliance—can be agreed upon and honored. Brilliance is manifested by doing something no one has done before.

Traditional notions in the philosophy of science demonstrate that the idea of “testability” needs to be clarified. No matter how many times a hypothesis is “verified” by a test, it remains possible that a later test will prove it false. The fact that your car has started everyday does not prove it will start tomorrow. In this sense, science presents us only with theories that fit the available data as best as possible under the circumstances. Those theories may well change as scientists learn more.

What then distinguishes a scientific theory from any other kind? To the philosopher of science Karl Popper it is “not the verifiability but the falsifiability of a system” that is a key criterion of its being scientific. Scientific statements are those that can, in principle, be disproved by an experimental result. This is why the vast majority of scientists do not, for example, regard astrology as science:

Astrologers can so hedge their predictions that they are devoid of genuine content. We may be told that a person will “tend to be creative” or “tend to be outgoing,” where the evasiveness of a verb and the fuzziness of adjectives serve to insulate the claim from repudiation. But even if a prediction should be regarded as a failure, astrological devotees can go on believing that the stars rule our destinies; for there is always some item of information, perhaps as to a planet’s location at a long gone time, that may be alleged to have been overlooked.

Given this approach, it is not surprising that we use the word science primarily when we speak of the natural sciences. The framing of falsifiable hypotheses and the running of controlled experiments is far more difficult, perhaps even impossible, when the subjects are people rather than chemicals or protons. In any event, for purposes of this book, scientists are those seeking cumulative, testable knowledge about natural phenomena. These are people who, when things go right, make progress in their chosen field.

There are important modern scholars who challenge this formulation. To some, all knowledge is contingent and dependent on cultural assumptions—not just the interpretation of a literary text, not just the conclusions of an economist, but even the laboratory results of a scientist. But
even from this perspective, science ends up appearing a good deal more progress oriented than other fields of human endeavor.

_The Kuhn Critique_

The starting point for modern critiques of the idealistic view of science is Thomas Kuhn’s enormously influential *The Structure of Scientific Revolutions*. Kuhn introduced the idea of a paradigm—a model, such as Newtonian physics, that is powerful and successful in explaining phenomena and attracting adherents, while sufficiently open-ended to leave problems that researchers can work on. Those who work within an established paradigm do not challenge its basic nature. They labor instead to solve the scientific puzzles that come up within the paradigm’s assumptions. Kuhn refers to this “puzzle-solving” activity as “normal science.” But over time, research results may challenge a paradigm itself. There then may be a revolutionary change—a paradigm shift—to a new paradigm, such as Einsteinian physics.

It is vital to remain clear where this account does and does not challenge the classic view of science. “Normal science” presents no such challenge; indeed, Kuhn himself describes normal science as “a highly cumulative enterprise, eminently successful in its aim, the steady extension of the scope and precision of scientific knowledge. In all these respects it fits with great precision the most usual image of scientific work.” It is with the paradigm shift that Kuhn sees something new, because “[t]he transition from a paradigm in crisis to a new one from which a new tradition of normal science can emerge is far from a cumulative process, one achieved by an articulation or extension of the old paradigm. Rather it is a reconstruction of the field from new fundamentals, a reconstruction that changes some of the field’s most elementary theoretical generalizations as well as many of its paradigm methods and applications.”

Under the circumstances, according to Kuhn, choices between an old and a new paradigm “can never be unequivocally settled by logic and experiment alone.” The data will often largely fit either paradigm, at least in the early stages of the revolution, and choices must be informed by other factors. Some suggest, for example, that a theory’s “simplicity” will attract scientists to it, a possibility that introduces a “nagging subjectivity” into the decision as to what counts in favor of a hypothesis.
Kuhn has argued that a theory will be judged in part by whether it is fruitful in the sense of setting forth a new research agenda, another factor that departs from a strict emphasis on laboratory results.

Kuhn's notion of paradigm shifts has not gone unchallenged by historians of science, some of whom still maintain that science proceeds in increments rather than through revolutionary shifts. But even within Kuhn's approach it is remarkable how much of the traditional model of science is preserved. This is sometimes obscured when people toss around the notion of "paradigm shift" outside of the natural sciences, and find such shifts on a monthly basis with little to choose between the old and the new paradigm. This is not the sort of thing Kuhn was writing about, and those who read The Structure of Scientific Revolutions in its entirety find that Kuhn marveled at the coherence of the scientific community, a community that ultimately reaches consensus on which paradigm should be followed. Thus, to Kuhn, the vital questions at the end are, "Why should progress also be the apparently universal concomitant of scientific revolutions? . . . Why should scientific communities be able to reach a firm consensus unattainable in other fields?" Kuhn speculates that the key is precisely that choices in science are made not "by heads of state" or "the populace at large," but rather by a "well-defined community of the scientist's professional peers."

After Kuhn, and to some extent independent of his work, other scholars have applied deconstructionist techniques in an effort to show that scientific knowledge is as culturally contingent as any other kind. In this literature also, however, there is recognition that the scientific community is remarkably adept at defining itself and at adjudicating what is and is not good science from its own professional perspective. Indeed, the argument that scientific knowledge is "constructed" and thus not objectively true in some ultimate philosophical sense strengthens rather than weakens the role of the scientific community in self-definition. The critique does open the door to alternate accounts of what ought to be considered good science, but those accounts have had remarkably little impact in the mainstream scientific community or in public perceptions of that community.

In any event, it is not necessary to resolve the ultimate philosophical status of science to proceed with our inquiry. The scientific community will never persuade everyone that its approach is a sure route to any
ultimate reality. Skeptics, from the ancient Greeks to the present, have asked whether science tells us more about the outside world or about ourselves. Scientists may put great emphasis on testable propositions, but whether one should do that is not itself testable. What we can say is that in our society today science is a remarkably well-defined activity with a vigorous band of practitioners who do experiments (not philosophy) and who appear to accumulate vast knowledge about the natural world. It also appears beyond reasonable doubt that this scientific community is of great importance to American society at large.

Thus the central reality from our perspective is that the scientific community in America today is a self-governing republic. Scientists, not governments or voters, decide what is good and what is bad science. Entrance into this scientific community depends on rigorous professional training, whereas high standing in that community is evidenced by membership in groups such as the National Academy of Sciences and the science faculties at major universities. The scientific community is not equally united on all issues. There are cutting-edge issues on which scientists are deeply divided or at least concede that science has not as yet reached a clear conclusion. In other areas, however, scientists are, if not unanimous, then nearly so. The scientific community retains its internal authority by agreeing that if individuals disagree on too many of these basic points, they are expelled from the community. It is barely possible to be a member in good standing of the American scientific community today if you disbelieve in evolution or believe in laetrile. It is impossible to be a member if you hold both views.21

The Limited Role of Practical Applications

Viewing scientists as members of a professional community who love progress may appear to leave out a central feature of the scientific endeavor: the emphasis on utility, on the technology that grows out of science and benefits the public at large. Many scientists do care greatly about the ultimate practical impact of their work, but that concern is often secondary to the fundamental search for knowledge. Practical utility is an uncertain basis for performing basic research because, as many scientists are aware, the link between science and technology is much more complex than the public usually supposes. The link between basic science and technology is often uncertain and indirect, and the
technology that results is sometimes, from the scientists' point of view, undesirable.

The uncertainty in the science-technology connection has three distinct aspects. First, many areas of scientific research turn out to be unproductive in scientific terms, let alone in terms of practical impact. There are no certainties in exploring the unknown and some research simply does not succeed. Second, even when research does result in a scientific advance, that is no guarantee of a practical payoff. Few discoveries have been more historic in intellectual terms than Einstein's general theory of relativity, which concerns the fundamental structure of the universe. The general theory, however—unlike Einstein's special theory of relativity, which led to nuclear energy—has had no practical technological applications in everyday life. Finally, even when a scientific theory does lead to important applications, they may be distant applications never imagined by the theorist. When Einstein published his initial work on the special theory of relativity, he had no idea it would ultimately lead to nuclear power. His first paper concerned fundamental properties of matter, space, and time; even he did not see the related energy-mass equivalence and its implications for several years.22

Finally, the science-technology link is not direct. It is rare for a scientific discovery to immediately lead to a new device. More often it takes a chain of scientific discoveries and engineering advances to bring a product to fruition. Indeed, although in theory inventions may always rely on some underlying scientific principle, many inventors have little or no knowledge of scientific theory and rely instead on their own intuitive ideas about improving previous inventions. Numerous studies, including those related to sophisticated post-World War II military inventions, show that many inventions are based primarily on earlier technology rather than on science.23 Of course, scientific theories may ultimately provide a full explanation of why a device works, but that is hardly an argument for the direct utility of science. Cooks have known for centuries that chicken soup makes you feel better; a modern scientific explanation of why that is so does not improve the world's cuisine.

Moreover, even in those areas where the practical implications of science are enormous, scientists may be reluctant to boast about them if those implications are undesirable. Scientists cannot control how society uses newly discovered powers and many scientists would oppose some of those uses, such as new weaponry, that society chooses. Thus, although
scientists might defend their work on the ground that new discoveries are inevitable and there is no telling where they will lead, that is very different from doing the research primarily because of its social impact.

In sum, whereas science can directly aid society, traditional scientists cannot rely on that as a sole or even fundamental motivation for their work. References to the unbreakable link between science and technology are useful at budget time, but not as useful as a central value for the working scientist.

The image of the scientist's values that emerges here—the love of progress, the caution about utility—was well illustrated in J. Robert Oppenheimer's speech to the Association of Los Alamos Scientists on November 2, 1945, a few months after the atomic bombing of Hiroshima and Nagasaki:

But when you come right down to it the reason that we did this job [building the bomb] is because it was an organic necessity. If you are a scientist you cannot stop such a thing. If you are a scientist you believe that it is good to find out how the world works; that it is good to find out what the realities are; that it is good to turn over to mankind at large the greatest possible power to control the world and to deal with it according to its lights and its values.24

Doing the scientific work that led to the atomic bomb is not a routine experience for scientists, but Oppenheimer's speech isolates values that are typical. Doing research is "an organic necessity" because to be a scientist means "finding out how the world works" and "finding out what the realities are." Last, chronologically and often in importance, is the "turning over to mankind at large" the fruits of your labors.

Process in Law

Does the law, with its focus on the affairs of mankind at large, share anything with the norms of science? Surely the fundamental thrust is in a different direction. The scientists' emphasis on progress is replaced by the lawyers' emphasis on process. Rather than seeking greater knowledge of the natural world, the law seeks the peaceful resolution of human disputes.

Saying the law emphasizes process is not to deny that individual laws have substantive content. A law punishing murder creates a substantive rule. But society has other rules and goals as well. The legal system and
the legal profession are primarily concerned with accommodating the numerous social goals applicable to a particular dispute in a socially acceptable way.

The evolution of legal rules in our society is largely the work of appellate judges who write opinions interpreting judicial precedents and the often vague language of statutes and the Constitution. These opinions cannot be tested in a strictly scientific way. Human history does not lend itself to the running of controlled experiments. Thus if a court in 1973 issues an opinion broadening the definition of obscenity so that a wider variety of books can be banned, it is difficult to test whether that decision is right. Suppose the decision was based in part on the belief that reading obscene books leads some people to commit sexual assaults. How can the belief be tested? Even if in the ten-year period following the decision there is a decrease in the number of rapes, the matter remains uncertain. Any number of factors might have caused that decrease. There might, for example, have been an increase in police patrols during the period. It is not possible to go back to 1973, issue a different decision, hold everything else constant, and see what happens to the crime rate. Moreover, even if we did have a sense of the effect of the 1973 decision on crime rates and on the equally uncertain question of what books were not written because of the new obscenity standard, we would still not be sure if the decision was right. Suppose we somehow knew that the 1973 decision led to a one percent reduction in crime, but also to the nonwriting of three great novels. There is no scientific way to balance these outcomes to decide which outweighs the other. Indeed there may not be a social consensus on how much crime reduction is worth how much literature.

This contrast can be overstated. Social judgments, however imprecise, can sometimes be reached on legal outcomes. If a court’s decision appears to lead to a sudden surge in the crime rate, it may be judged wrong. If it appears to lead to new opportunities for millions of citizens, it may be judged right. The law does gradually change to reflect this kind of social testing. But the process is slow, uncertain, and controversial; there is nothing in the legal community like the consensus in the scientific community on whether a particular result constitutes progress.

An additional pressure on the legal system is that whereas ultimate judgments of right or wrong may take decades, particular disputes must be resolved more quickly. The law does not have the luxury of waiting
for all the relevant evidence to come in, because with public policy delay is a decision. While we wait, an individual is or is not in jail; a power plant is or is not constructed. Law must stress process in part because it is not in a position to ascertain ultimate truth. As Peter Schuck has argued:

The law is usually in much more of a hurry to decide than science is. Ironically, however, law’s findings, although less reliable and tested than those of science, are treated as more final and authoritative. Law operates under pressure to resolve particular disputes speedily and conclusively. . . . [Scientific] consensus often takes a long time to assemble, yet even then it is conditional, always open to revision on the basis of new data or theories.25

If an appellate judge’s opinion cannot be tested in a scientific way, how is it to be assessed? On its face, an opinion often appears to be, in part, an effort at a logical demonstration. General principles are stated and deductions are made. Yet a judge’s opinion obviously is not a mathematical proof. At any given moment in the history of mathematics there is, in a particular field, reasonable agreement on the definition of terms and on the postulates to be used.26 There is no such consensus in our society about legal principles. Two judges can use impeccable logic and yet reach different results because their assumptions vary. One might postulate that free speech is of value only to the extent that it furthers other goals, such as an informed electorate, while another believes speech is a good in its own right. Or the judges’ disagreement may manifest itself in a dispute over definitions: for one judge “speech” includes musical performances, for the other it does not. Thus, any notion of assessing judicial opinions in purely formal terms is unlikely to succeed.

That judicial opinions are neither scientific nor mathematical does not mean they are irrelevant. The opinions themselves are part of the process by which socially acceptable decisions are reached. After all, why write an opinion if it does not irrefutably “prove” anything? In a society in which the rule of law meant nothing more than brute force, courts could simply issue judgments without explanation and police could enforce them. In our society, however, judicial opinions themselves become part of the governing process as people judge their strengths and weaknesses and, if unpersuaded, work to change the law. Judicial opinions then, although they are not right or wrong in scientific terms, are successful or unsuccessful depending on the extent to which
they effectively draw on commonly held values to persuade the interested segments of the population. Judges, in other words, engage in the practice of rhetoric—not rhetoric in the modern, pejorative sense of ornate or empty linguistic flourishes, but rhetoric in the older sense of persuasive communication designed to win support for views on questions of values.27

It might be argued that whereas fundamental legal questions are not susceptible to scientific proof, the factual questions often involved in legal proceedings are. It is true that most legal disputes involve factual issues. For example, a jury must decide where a person was on a given date, and an agency must decide how much radiation escaped from a reactor. Surely, one might argue that these matters could be resolved in a scientific manner. The courts could then apply the legal tests—what is a crime or what is an unsafe level of radiation—to the scientifically established facts.

Of course, some factual issues do not lend themselves to a strict application of the scientific method; there is often no certain way to test conflicting stories about the whereabouts of the accused. But there is, nonetheless, cause for believing that some legal facts can be derived scientifically. Our legal system does separate, to some extent, factual from legal questions by having a jury or an expert agency make factual decisions while leaving the ultimate resolution of legal questions to judges. But even here it would be a mistake to think that the scientific approach plays a dominant role.

The law is rarely concerned solely with factual truth in the scientific sense because that is rarely society's sole concern. Consider, for example, the trial of a criminal case. John Smith is accused of murdering Mark Evans at 6 p.m. on August 1. If the only question were a narrow factual one—that is, did Smith kill Evans at the time stated?—one would expect our society to resolve that question in at least a quasi-scientific way. Although it may not be technically possible to verify assertions about the past scientifically, we could at least attempt to limit the judicial system to an objective, expert inquiry into what happened last August 1.

Under this approach, the inquiry would presumably be conducted by people with expertise in such matters. We might expect to see, for example, the growth of a profession of "fact finders" wise in the ways of fingerprint analysis, eyewitness testimony, and the like. We would not
expect to see what we presently have—a lay jury utterly inexperienced in the narrow task of factfinding. But that is because the narrow factual question—whether Smith killed Evans at the time stated—is only one of many questions of interest to society. Suppose Evans was a terminally ill, elderly patient in intractable pain, and Smith, his doctor and best friend, halted his treatment? Or suppose Evans was a healthy athlete running down the sidewalk, whereas Smith was a mentally ill or drunk driver who swerved onto the sidewalk for no good reason, accidentally killing Evans? Or suppose that Evans had threatened Smith at 5:30 p.m., and when Smith saw Evans at 6 p.m. he killed him, wrongly believing Evans was about to pull a gun? The legal doctrines that have grown up around cases like these make clear that society wants juries to make moral and practical judgments as well as purely factual ones.

Technically, the judge tells the jury the relevant law—whether it be on euthanasia, the insanity defense, self-defense, or some other doctrine—and the jury finds the facts. In practice, however, the law and the facts are so closely intertwined that the jury will do more than simply find the facts. It will, within the broad outlines of the relevant legal doctrine, decide whether applying a doctrine such as self-defense is sensible in the case before it. Society does not want jurors to be automatons; it wants them to make the unavoidable moral judgments involved in applying disputed facts to necessarily imprecise legal doctrines. As Holmes wrote in 1899:

I confess that in my experience I have not found juries specially inspired for the discovery of truth. I have not noticed that they could see further into things or form a saner judgment than a sensible and well trained judge. I have not found them freer from prejudice than an ordinary judge would be. Indeed one reason why I believe in our practice of leaving questions of negligence to them is what is precisely one of their gravest defects from the point of view of their theoretical function: that they will introduce into their verdict a certain amount—a very large amount, so far as I have observed—of popular prejudice, and thus keep the administration of the law in accord with the wishes and feelings of the community.28

Much the same is true with the heads of administrative agencies. In regulatory decisions we want agency members who can make clear-eyed factual judgments. But, we also want them to be able to make the sound policy decisions inevitably involved when legal principles are coupled with disputed facts. Under many statutes, for example, judgments on an
appropriate level of environmental safety involve a variety of factors, including cost, emission levels, compliance levels, and the like. Courts have generally held that agencies must consider the numerous private interests affected by their decisions as an “essential predicate” to balancing all of the elements necessary for a just determination of the public interest.29

Thus, on both legal and factual matters, our legal system stresses the process by which a decision is reached in an attempt to ensure that the decision will be, at the very least, something society can accept. The most dramatic manifestation of this concern for process is the adversary system, under which lawyers for each side present the best arguments they can to support their client’s case. The individual lawyer, of course, is not seeking the truth; it is the process itself that is supposed to foster accuracy by presenting the judge or jury with the best arguments on both sides. But if accuracy were the only concern, it is not obvious that the adversary system would be used. A vigorous investigation by an impartial expert might do as well. Scientists, after all, rely heavily on peer review. The adversary system, however, serves process goals. It provides both sides with a highly visible day in court—a public presentation of views, ensuring that all sides are heard. Part of the value of such a day in court may be cathartic, but that too contributes to the peaceful resolution of disputes.

Consider in this light the observations of David L. Bazelon, when he was Chief Judge of the U.S. Court of Appeals for the District of Columbia, a federal court with a heavy volume of cases involving scientific and technical issues. Concerning such cases, Bazelon advocated open decisionmaking after a full airing of opposing views:

This kind of openness is in everyone’s best interests, including the decisionmakers’... When the issues are controversial, any decision may fail to satisfy large portions of the community. But those who are dissatisfied with a particular decision will be more likely to acquiesce in it if they perceive that their views and interests were given a fair hearing.30

There is quite a contrast between Oppenheimer’s assertion that it is “an organic necessity” for scientists “to find our what the realities are”31 and Bazelon’s observation that legal process, at best, “may fail to satisfy large portions of the community,” but at least it can earn “acquiescence” if the contending parties are given “a fair hearing.”
Under the circumstances it is not surprising that a lawyer's work rarely shows outward signs of brilliance. Attorneys present views they know are one-sided as part of an overall process designed to ensure fairness. A judge disguises new ideas as old in order to enhance their social acceptability. At best, resolving human conflicts is an imperfect, unending task in which progress is difficult to define, let alone measure.

Thus the fundamental difference in values between science and law is subtle, but important. Science is not a compendium of timeless true statements. It is, in a sense, a process for formulating and testing hypotheses about the natural world, hypotheses that are always open to revision. But in science this process is a means to an end, and that end is progress in our knowledge of the world. In law, process is not simply or primarily a means to an end. In an important sense, process is the end. A fair, publicly accepted mechanism for peacefully resolving disputes is often the most one can reasonably ask for in human society. As Justice Felix Frankfurter wrote in an opinion for the U.S. Supreme Court, "the history of liberty has largely been the history of observance of procedural safeguards." 32

The fundamental difference between the scientist's love of progress and the lawyer's adherence to process has secondary implications for the value systems of scientists and lawyers. Scientists looking for empirically verifiable truth have to believe there is some kind of order in their universe, whether it is expressible in traditional cause-and-effect terms or in probabilistic equations. And the search for order is closely allied to the search for beauty—scientists often testify to the aesthetic motivations for their theories. From a scientist's perspective, beauty and simplicity are not sought, as some non-scientists contend, because there is no other way to choose between theories. Rather, beauty serves to confirm a theory's accuracy because of a scientist's underlying faith about the very nature of the universe. Werner Heisenberg, for example, wrote, "I frankly admit that I am strongly attracted by the simplicity and beauty of the mathematical schemes with which nature presents us." 33 Judges, by contrast, confronted with the pressing need to resolve a social dispute peacefully, will often trade order and beauty for a patchwork solution that works for the problem before them. As Jerome Frank wrote, "[M]ost judges are too common-sensible to allow, for long, a passion for aesthetic elegance, or for the appearance of an abstract consistency, to bring about obviously unjust results." 34
Now, of course, this depiction of scientists and lawyers as champions of progress and process is the depiction of ideals, not of living, breathing human beings. Like everyone else, scientists and lawyers may be motivated by greed, lust, or an insatiable desire to be famous. Moreover, the problems they work on do not grow out of abstract conceptions of progress or process, but rather out of the social and cultural environments in which they live. But the fact remains that these professional norms of progress and process shape the professional lives of scientists and lawyers, and shape them in very different ways.

*The Daubert Case*

The contrast between progress and process was on display when the U.S. Supreme Court discussed the admissibility of scientific evidence in 1993.

The case of *Daubert v. Merrell Dow Pharmaceuticals*\(^{35}\) arose when Jason and Eric Daubert were born with serious birth defects. During pregnancy, their mother had taken Bendectin, a prescription antinausea drug marketed by Merrell Dow. Believing that Bendectin had caused the defects, the Dauberts brought suit.

At trial, Merrell Dow was able to show that numerous published epidemiological studies concerning Bendectin failed to establish any link with birth defects. The Dauberts responded by proffering expert witnesses, who challenged the conventional wisdom that Bendectin was safe on several grounds. In particular, the Dauberts wanted to introduce experts who reanalyzed the published studies and obtained different results, although this reanalysis had not itself been published.

The trial court ruled, among other things, that the Dauberts could not present the jury with experts who relied on unpublished reanalysis. The court applied precedent holding that only techniques "generally accepted" as reliable in the relevant scientific community could be presented by expert witnesses to juries. The trial court, following the lead of other federal courts, concluded by ruling in favor of Merrell Dow. After a federal appellate court affirmed, the case reached the U.S. Supreme Court.

In the Supreme Court, the technical issue was whether the Federal Rules of Evidence displaced the "generally accepted in the scientific community" test that the lower courts had used, and, if so, what the
new test should be for the admission of expert scientific testimony. But the case attracted considerable attention in the scientific community because of its broader implications. Numerous scientists banded together in groups and filed thoughtful briefs. From our point of view, they are of particular interest because of the insight they provide into the scientist’s world view.

The scientific community was not united on the proper approach to the question of the admissibility of expert testimony. This was, after all, not a matter that fell within some consensus concerning what is good science; indeed, it was not a scientific question at all.

The scientists who addressed the Court largely fell into two groups. The first supported the proposition that judges needed considerable power to prevent juries from hearing testimony from witnesses who were far outside the mainstream of the scientific community. These scientists were concerned with “pseudoscience” or “junk science” that does not contribute to the search for truth. As one brief put it, “The impact and influence of scientific rhetoric can easily sway and mislead a jury.” Particularly when potential witnesses have not published their conclusions, there is the danger that these witnesses are biased in favor of one side in the case; in other words, there is the danger that legal rather than scientific norms drove the research:

Quite often, the experiments will have been conducted with a pending case or at least potential litigation in mind. On the other hand, scientific journals are typically concerned with progress in a particular field, and in making progress with sound methodology.

On the other side were scientists equally devoted to the cause of scientific progress, but they focused on the more dramatic kind of progress that often is resisted initially in the scientific community. These scientists were inclined to let the jury hear and evaluate any expert’s ideas; any screening role for the judge was suspect:

Science progresses as much or more by the replacement of old views as by the gradual accumulation of incremental knowledge. Automatically rejecting dissenting views that challenge the conventional wisdom is a dangerous fallacy, for almost every generally accepted view was once deemed eccentric or heretical. Perpetuating the reign of a supposed scientific orthodoxy in this way, whether in a research laboratory or in a courtroom, is profoundly inimical to the search for truth.
The Supreme Court ultimately ruled that the old "generally accepted in the scientific community" test had indeed been superseded by the Federal Rules of Evidence. But, beyond that, it did not endorse either of the approaches presented by the briefs for the scientists. The Court declined to say that judges should screen out all expert scientists who deviate from accepted approaches, but is also declined to say that judges should play no gatekeeper function at all. It crafted a traditional legal compromise, setting forth a variety of factors, such as whether the testimony proffered had been tested or published or widely accepted in the scientific community. These factors, none of which are dispositive, are to be applied on a flexible, case-by-case basis by trial judges. Clearly the question of what sort of expert evidence gets to the jury will emerge, indeed will be indistinguishable from, a continuing process of individual dispute resolution. In certain cases, juries will hear controversial experts; in other subtly different cases, they will not.

In the course of reaching this rather traditional legal result, the Court gently responded to the all-or-nothing rhetoric contained in some of the scientists' briefs. As to the first group—the scientists who maintained that pseudoscience would mislead the jury—the Court replied by noting the numerous procedural devices that protect against this eventuality when an expert with unconventional views testifies. The Court found that the scientists were "overly pessimistic" about the capabilities of the adversary system, given the availability of "[v]igorous cross-examination, presentation of contrary evidence," and the like. The Court also noted that a judge can even direct a verdict after testimony has been given if the evidence presented is extremely weak.

On the other hand, the Court criticized those scientists who, in the name of Galileo, maintained that judges should perform no gatekeeper function at all. The Court recognized that even a flexible gatekeeper will at time prevent the jury from learning of "authentic insights and innovations." But, the Court stressed, that cannot determine the issue: [T]here are important differences between the quest for truth in the courtroom and the quest for truth in the laboratory. Scientific conclusions are subject to perpetual revision. Law, on the other hand, must resolve disputes finally and quickly. . . . [T]he Rules of Evidence [are] designed not for the exhaustive search for cosmic understanding but for the particularized resolution of legal disputes.
In the end, all of the scientists in the Daubert case were preaching on behalf of scientific progress. Some stressed the careful progress of “normal science” where professional competence weeds out pretenders. Others emphasized the paradigm shifts of “revolutionary science,” where progress threatens the old establishment. The Court gave weight to both concerns, but within a framework of process values in which final resolutions on imperfect data are often necessary.

It would be a mistake to believe that these differences between law and science prevent members of these professions from understanding each other. There is no reason why lawyers and scientists cannot comprehend the different nature of the other’s work and appreciate when it is being done well. A lawyer can admire a scientist who frames and tests a beautiful hypothesis about the structure of the stars. It would be a misguided lawyer indeed who complained that due process protections were not provided when the hypothesis was created. A scientist can admire a legal system that crafts a workable solution to a nasty problem of self-defense in homicide cases. Only a remarkably narrow-minded scientist would complain that the solution was insufficiently scientific.

The real conflicts arise when law and science begin to infringe on each other’s turf. The most important area for such problems today is the social dispute in which a high level of technical information is involved. In such cases the differing value systems of lawyers and scientists can indeed lead to problems, for example, in disputes over the safety of nuclear reactors, the risks of genetic engineering, and the efficacy of new drugs. In the pages that follow, I argue that these problems arise largely from vastly different legal attitudes toward basic research as opposed to the application of that research.

Defining Terms

Obviously this approach requires that I explain how I am using terms such as basic and applied research. It is notoriously difficult to draw sharp distinctions in this field because there are no bright lines on the continuum that stretches from pure science through applied technology.47 Let me begin by discussing the pure science end of the continuum.

The values of the scientists discussed previously are based on the institution of pure science. Pure scientists pursue knowledge wherever it
leads and for its own sake. Their work may, as we have seen, lead to practical applications, but those applications are often years away and come in areas the scientists themselves never would have predicted. Under the circumstances, it is not surprising that relatively few American scientists actually do absolutely pure science. Most of what is usually called scientific research, including most of the research funded by the government, is a step or two over on the continuum from pure science. Although it might be called basic research, it is part of a program designed to accomplish a particular mission. Unlike pure scientists, the government and others funding research are primarily interested in utility, that is, in practical results. Thus, a university scientist receives a grant to do cancer research. This scientist’s work may involve gaining a fundamental understanding of cellular processes and it may lead to surprising findings with unexpected implications. But the work is being funded because it may lead to a cure for cancer. Or, consider a scientist in a national laboratory doing research on materials for solar collectors. This person’s work may involve learning basic facts about the properties of certain elements, but it is mission-oriented work, aimed toward the ultimate development of a solar energy device.

When I discuss legal attitudes toward basic research, I will typically be referring to mission-oriented research, not absolutely pure research. But it is important to realize that scientists doing mission-oriented research draw their value system largely from pure science. As Victor Weisskopf wrote, “The style, the scale, and the level of scientific and technical work are determined in pure research; that is what attracts productive people and what brings productive scientists to those countries where science is at its highest level.” Most of our examples of basic research will concern university scientists working under research grants from federal agencies like the National Institutes of Health or the National Science Foundation. Although they are working as part of an overall mission, these scientists want to make scientific progress, add to the cumulative store of scientific knowledge, and publish in reputable scientific journals. Thus, in achieving the government’s goals, they look, to the extent possible, for the most scientifically attractive solution, which means the one that establishes progress and priority in scientific terms.

When I discuss legal attitudes toward applications of science, I will be moving away from pure science and mission-oriented research and to-
ward the production of new products for the marketplace. Here the emphasis will be on such developments as energy systems that are ready to be tested, drugs that are ready to be marketed, and computer systems that are starting to go on-line.

Let us begin then with legal attitudes toward basic research. As with much of American law the starting place is our fundamental charter—the U.S. Constitution.