1. Introduction

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America's relationship with science is paradoxical. On the one hand, we proudly support basic research that yields stunning breakthroughs and Nobel Prizes. We then relish the ensuing debate about the implications of scientific advances. Will genetic engineering change our basic nature? Will artificial intelligence challenge our sense of human uniqueness? On the other hand, the actual implementation of new technology is often slow and sporadic. The technologies that were supposed to provide abundant energy, inexpensive medical care, and a new sense of humanity always seem a few years away. The result is grumbling about a wasteful and uncompetitive American economy.

The cause of this paradox is the subject of this book. The slippage between the promise of American science and the reality of commercial technology has triggered national debate. Some blame government regulation for the burdens on technology; others call for government support of new products in an effort to mimic Japan.

But the roots of the paradox lie deeper in the soil of American society. Government "regulation" and "support" do not appear by magic or disappear by fiat. Understanding our situation requires a detailed look at the intersection of two cultures—law and science—rarely considered in tandem. Their relationship encompasses far more than a court injunction against a power plant; it shapes the entire process from basic research to public debate about values to the implementation of new technology. Our analysis will show the fundamental strengths and weaknesses of our research-and-development system as well as explain what measures could alleviate the current gap between promise and performance in American science.

The book begins, in this chapter and the next, by looking at the dominant position of law and science in American culture and at the characteristic ways of thought of lawyers and scientists. The process orientation of lawyers is contrasted with the progress orientation of scientists.

We turn next, in chapters 3 and 4, to the legal status of America's basic research effort. We demonstrate how the Constitution and the relevant statutes provide extraordinary support for basic science and for the central role of the scientific community in controlling the direction of research. The legal community, including the courts, is seen to be remarkably weak in this area.

Chapter 5 looks at the legal status of religion, a possible counterweight to the scientific perspective. In the American legal system, however, religion fares poorly when it conflicts with science; consequently, not only scientific research but scientific perspectives on moral issues permeate our culture.

Chapter 6 turns to the commercialization of technology and demonstrates that here the constitutional and statutory system puts the lawyers firmly in charge. The scientific world view, far from being dominant, is a marginal factor. The result is what I call the *regulatory gap*, the cause of the screeching halt that often greets new ideas that fared well in the scientific world but not so well in the world of the lawyers. The paradigmatic case of nuclear energy is among those considered. The emergence of what I term the *science counselor* is also described, as scientists attempt to bridge the regulatory gap by bringing social concerns into play earlier in the research process.

Chapters 7, 8, and 9 present case studies of the human genome initiative, nuclear fusion, and artificial intelligence. In each situation, dramatic research is shaping our hopes and our values. But in each case, the regulatory gap looms dead ahead as the controversial social consequences of new technology, processed through the lawyers' adversary model, make restrictions and delays inevitable in our pluralistic society. We see as well that science counselors are at work in all three areas limiting our expectations and boosting public approval for socially acceptable technology. Chapter 10 concludes with a summary of the relationship between law and science in America and a set of suggestions for strengthening the role of science counselors without imperiling pure research.

Underlying our entire treatment is the reality that science and law are central features of the American social and cultural landscape. With science, the evidence is clear—from the Enlightenment goals of the framers of our Constitution to the latest proposals to "fix" our social problems, the scientific world view has long influenced American ways of thought and policy-making.[1] The scientific stress on progress and on the new has matched the American ethos at many points.[2] As a result, pure scientists enjoy a more favored role in the United States than in any other society. References to the "scientific establishment" in America are routine; indeed Ralph Lapp took the next step and called scientists "the new priesthood."[3]

At this point it is customary to note that scientific perspectives face a humanistic rival in shaping our society. The "two cultures" idea, popularized decades ago by C. P. Snow, has come to stand for the notion that two ways of thought—scientific and artistic—compete for authority in modern life. They should, according to Snow, learn more about each other, but they are the two dominant points of view.[4]

It is customary to invoke Snow's two cultures, but it is wrong. The notion that literary values operate as some kind of equal counterweight to scientific values in modern American attitudes and policy-making is simply untenable. It should be noted from the outset that the two cultures idea has always had a distinctly British, as opposed to American, provenance. In 1959, when C. P. Snow delivered "The Two Cultures, and the Scientific Revolution" as the Rede Lecture at Cambridge University, he did discuss America as well as Great Britain as suffering from a "gulf of mutual incomprehension" between scientists and humanists.[5] But just five years later, in his "Second Look," Snow noted that in America the gulf was nowhere near as large as in Great Britain:

> In the United States, for example, the divide is nothing like so unbridgeable. There are pockets of the literary culture, influenced by the similar culture in England, which are as extreme in resisting communication and in ceasing to communicate; but that isn't generally true over the literary culture as a whole, much less over the entire intellectual society.[6]

But even to talk about "the literary culture as a whole" in America today is to take a leap of faith. There is concern that students receive humanistic values in their education, but the fragmentation of the American literary intelligentsia makes even this concern virtually impossible

to satisfy. Poll any ten recent graduates from ten American colleges. If there are two serious literary works that have been read by a majority, your poll will make history.

It is impossible here to assess all of the factors, ranging from the mass media to the nature of American universities, that have weakened coherent humanistic values in American life. One key reason may well be the very interchange between science and literature called for by Snow. Beginning in the 1930s and accelerating in recent years, literary intellectuals have read and talked a great deal about the philosophical issues raised by modern physics. The notion of relativity and the probabilistic nature of quantum physics have given rise to considerable musing about cause, effect, and reality. Scientists, of course, although aware of the philosophical issues, have plowed on with their work, explaining ever more of the world in terms of their empirical approach. Many literary intellectuals, however, have been happy to leave the field of reality by saying that literature and science are united in being fundamentally fictitious ways of describing the universe. The impact of this on education has been substantial. As Gerald Graff has written, "students are quick to perceive that their [literature] teachers no longer hold the naive view that literature can explain anything."[7]

Whatever the reasons, the progressive, empirical values of science utterly overwhelm literary values in American culture today. As Peter Schuck put it in his perceptive commentary on Snow's work, "misunderstandings between science and literature today are rather a sideshow, peripheral to the main event."[8]

Even the social sciences—such as economics, political science, and psychology—are enormously influenced today by the scientific approach, with its emphasis on quantifiable, testable results. Indeed, this may be yet another reason why literary values do not counterbalance scientific values. According to Gertrude Himmelfarb, humanists have "chosen to capitulate" to science, and thus we have seen "the attempt of political philosophy to transform itself into political science, history into social science, literary criticism into semiotics, and most recently, theology into semantics."[9]

But there is a limit to the influence of the scientific world view in America, and that limit opens the door to the legal culture. Science alone cannot produce consensus on public policy issues, even though those issues often involve technical factors. When a new power plant is pro-

posed, citizens with different incomes, backgrounds, and places of residence can all adduce sophisticated arguments as to why their position, for or against the plant, is more persuasive. After all, environmental groups, no less than industry groups, rely on scientific expertise. The ultimate questions that must be resolved in public policy involve diverse interests and values, not scientific calculations. In our culture, these ultimate questions must be resolved peacefully, if not rationally, and divergent interest groups must be heard, even if they are not all equally expert.

In the resulting culture of dispute resolution, the lawyers are king. It is a commonplace observation (and a correct one) that lawyers dominate modern American legislatures, state houses, and government agencies, and most public issues end up, in whole or in part, in court. It is also an old observation, going back not only to de Tocqueville in 1835,[10] but to Edmund Burke, who told the House of Commons in 1775 that in the American colonies the legal profession "is numerous and powerful; and in most provinces it takes the lead."[11] As to why law is so vital in America there are as many theories as there are for the lack of vitality in the literary culture. Law may have benefited, for example, from the nature of American democracy, from the heterogeneity of American society, and from the absence of an American aristocracy.[12] In any event, a mature and powerful legal system is in place as the primary social testing ground for scientific developments with policy implications. There are, to be sure, rival arts. In recent decades, business schools and public policy schools have begun to produce policy analysts of various stripes seeking a major say in science policy decisions. It is too early to say whether these disciplines or some combination of them will someday provide a coherent alternative framework to the legal system for resolving important social disputes. At present they do not. Their insights today are often important only to the extent to which they can be brought to bear in a legal proceeding. A government official may be upset when a memo runs into problems with a policy analyst. This official's situation is much worse, however, when the memo runs into problems with the general counsel.

Thus it is law and science today that provide the central frame of reference for the policy disputes brought on by advances in research. Under the circumstances, we begin by looking at the ways of thought of lawyers and scientists.