A Guide to

# The Culture of Science, Technology, and Medicine

General Editor
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# *Preface*

The heart of *A Guide to the Culture of Science, Technology, and Medicine* is a set of state-of-the-field surveys of nine academic disciplines that take as their object science, technology, and medicine. They are integrated in this volume by a focus on value issues in the sciences and biomedicine. The surveys are a product of close collaboration between the authors and the area editors. The editors were also responsible for overall coordination; Arnold Thackray, who served on the board in addition to authoring a chapter, was particularly helpful in this respect.

Possible users of this volume, it was assumed from the outset, should include scholars in neighboring fields—philosophers of science, for instance, who may want to learn more about the history or sociology of science. However, members of the technical community and the interested educated general public ought also to be interested.

More than anything else, the volume should be useful to teachers of interdisciplinary courses in technology and values or science and society. Such teachers have often been faced with a difficult task of collating materials from innumerable and disparate sources. We have tried to gather as many of these as we could, discussing them explicitly, commenting on them in bibliographic essays, or, at the very least, listing them in bibliographies that attempt to balance comprehensiveness with utility.

Another recent source, *Science, Technology and Society: A Cross-Disciplinary Perspective* (1977), edited by Ina Spiegel-Rösing and Derek de Solla Price, focuses more on the social sciences. With the *Guide* and *Science, Technology and Society*, teachers in these interdisciplinary courses now have useful guides to both social science and the humanities.

The idea behind *A Guide to the Culture of Science, Technology, and Medicine* is due mainly to Dr. Richard Hedrich, director of science values projects at the National Endowment for the Humanities. When he was approached by Carl Mitcham for support of ongoing bibliographic efforts in

the philosophy of technology, the request set him thinking about applications he had been receiving from a number of similar fields. Ought they not be related? Why not try to find some integration among them? The idea was discussed with two of our editorial board members, Melvin Kranzberg and Derek Price. Kranzberg then undertook the effort to publicize the venture in scholarly circles. It fell to the general editor to collect a wide variety of inputs and give the project its final form. In due course the project was funded by NEH along with the National Science Foundation.

The able assistant to the general editor for the project was Elise B. Harvey; her warmth brought a human quality to the sometimes exasperating interchanges between editors and authors which was appreciated by all. Fran Durbin contributed generously to this process and put up with much, especially during final editing. Final typing was done by Betty Dickinson, with a whole host of secretaries at the authors' various home institutions handling earlier versions of chapters and other chores.

# *Introduction*

Two basic problems are addressed in this volume. One is the continuing split between the sciences and the humanities—once infamous as the "two-cultures" gap.[1] The other problem is less familiar. It has to do with fragmentation. Each of the humanistic and social science disciplines focusing on science and technology—the history of science or technology, for instance, or philosophy of science or science policy studies—goes its own way. And all these disciplines, for the most part, steer clear of explicit application to ethical and other value issues associated with science, technology, and medicine.

The volume has a dual aim: to attempt to establish an interdisciplinary whole by surveying nine currently fragmented humanistic and social fields dealing with science, technology, or medicine; and to bring about this integration by focusing explicitly on the help these disciplines might afford to those attempting to deal with major contemporary value questions in science and technology.

This objective is achieved in two steps. The general introduction suggests one way in which the nine fields surveyed here might be integrated —under the heading "culture of science disciplines." The second step is the remainder of the volume, comprising surveys of the fields, with extensive bibliographies. Whenever possible, the state-of-the-field surveys refer to other fields and to the overall integrative focus around value issues.

## PART I. GENERAL INTRODUCTION

The idea behind calling this volume *A Guide to the Culture of Science, Technology, and Medicine* is similar to the one that motivated others to title educational programs "Science, Technology, and Values" or "Human Dimensions of Science." Indeed, another satisfactory title might have been "Value Issues in Science, Technology, and Medicine." One reason for preferring "culture" to "values" in the title is that the volume addresses not

only value issues *in* the sciences but also the value *of* science—the place of science, technology, and medicine in contemporary culture.

## Approaches to Value Questions

"Axiology" or "the general theory of value(s)" has, it is claimed, "provided unification for the study of a variety of questions—economic, moral, aesthetic, and even logical—that had often been considered in relative isolation." [2] Philosopher Ralph Barton Perry, often said to have provided, in his *General Theory of Value* (1926), the *magnum opus* of twentieth-century treatments of values, equates "value" with "any object of any interest." [3] Later, in *Realms of Value* (1954),[4] he touched upon eight such values: morality, religion, art, science, economics, politics, law, and custom. Most authors would probably agree readily with Perry that morality, art, and custom belong among the "realms of value." Others would find little difficulty in adding law and religion. The inclusion of economics can be explained historically: the term "value" was widely used in economics before being generalized, mainly in the twentieth century, to other areas. What about science as a "realm of value"? This is the central issue with which we are concerned in *A Guide to the Culture of Science, Technology, and Medicine.*

## The Meaning of "Values"

Values can be considered, at risk of oversimplification, in two ways. The social sciences, from psychology to anthropology, from economics to political science, attempt to *describe* values, value preferences, and value systems. Sometimes the descriptions are embedded in cross-cultural theories, personality theories, or general economic theories; more often values are presented purely descriptively. Philosophers, on the other hand, have traditionally attempted to evaluate values—to define what *ought* to be, rather than simply what is, valued.[5]

In this volume, such an oversimplified distinction, although helpful as a first approximation, will not do the whole job. Historians of science and technology, for instance, do not fit neatly into either category. They sometimes describe the values of science or the cultural values that lead to advances in technology; but at other times they also make value judgments with respect to particular periods or groups in the history of science. Similarly, some sociologists of science or medicine venture into "normative sociology," taking stands on issues facing the technical community. This is also clearly true in science policy studies. Even the philosophers reported on in this volume are divided, some feeling freer to talk about what *ought* to be the case, and others trying to be merely descriptive.

Most generally, at least since the time of Plato, philosophers have discussed the question whether something is valuable (good, etc.) because it is valued, or whether it is valued because it is (intrinsically, objectively, in-

tuitively) valuable.[6] Again most generally and at the risk of oversimplification, it can be said that there are four main types of philosophical value theorists: There are "subjective absolutists" (for instance, G. W. F. Hegel and other Absolute Idealists) and "objective absolutists" (e.g., natural law theorists); there are also "objective relativists" (utilitarians, for example) and "subjective relativists" (existentialists).

A fifth category perhaps ought to be added: "critical theorists" who claim to do no more than criticize the statements or views of the other four types. Immanuel Kant's "critical" philosophy may be viewed as the first of such modern ethical theories. More recent "metaethicists" (the "emotivist" A. J. Ayer, or the "prescriptivist" R. M. Hare, for instance) clearly fall under this heading.

It is useful to make some distinctions among key value terms:

1. "Value," "good," "goal," "end," "motivation" are all value terms with somewhat different connotations. Sometimes, as in Perry's theory, all such value terms are taken to be equivalents of "interest." At other times, an author will reserve "value" for something concrete—e.g., economic values—and leave "good" to the philosophers. The other terms usually appear in specialized contexts.
2. For "value," the basic distinction is between "inherent" and "instrumental."
3. "Goal" is generally used only in making a long-range/short-range distinction.
4. "End" is frequently used as a synonym for "goal" or "good" or even "value" where the means–end distinction is important.
5. "Motivation" is often a substitute for other value terms in social science literature.
6. Finally, we must add "policies" to the list, meaning choices—usually social—among goals or ends. There are long-term policies and short-term policies, and "strategic" and "tactical" choices *among* policies, as well. Going even farther afield, such terms as "ideology," which have more specialized uses, have a value component.

This wide divergence among usages of value terms is one thing that has made a general theory of value(s) seem attractive.

A second set of distinctions bears on differences between science, applied science, and technology. Some maintain that, at least in the ideal, pure science is different from applied science and technology in that its only value is truth for its own sake. Applied science is assumed to add the dimension of practicality, and technology to bring in a whole host of social, cultural, and even ideological values. Medicine is an even more complex matter, involving, as it does in its current Western mode, science, technology, and the "art of healing."

All these distinctions, however clear they may seem, are subject to a wide variety of interpretations and to much dispute, as is clear in the chapters that follow.

### Social Science Theories

There is no neat schematization of social science treatments of values that closely parallels the above list of general philosophical theories. Anthropologists have almost always been concerned with cross-cultural comparisons of value systems. Sociologists, especially of the methodology-oriented American school, for a long time avoided problems of value, usually getting at values only indirectly through the study of organizations or groups, though in more recent years, especially with the rise of "normative sociology," this has been less true; however, value neutrality still remains a goal of many, especially behaviorist-oriented, sociologists.[7] (Sociologists of science for the most part followed the patterns of sociologists generally, though early on there was an attempt to discover empirically the peculiar value system of the scientific community.[8]) Social psychology is a field sharply divided between behaviorists and more "subjective" theorists (for example, symbolic interactionists), with the latter much more likely to focus on values and value systems, typically those of small groups. Historians and political scientists have recently come to be considered partly within the social science category, especially when they make use of quasieconometric models. Traditionally they would have been thought of as closer to philosophers in saying not only what is, but what ought to be, valued. Among practitioners of the disciplines surveyed here, science policy students have very often attempted to use econometric or "systems theory" models.

Some social scientists believe that it is possible to measure value preferences and to differentiate between various groups—national cultures, ethnic groups, occupational groups including scientists—and so on—in quantitative terms.[9] They even believe that such a venture can lead to significant theoretical unification among the social science disciplines, though it is currently too early to tell what other social scientists will make of this bold claim.

In short, the discussion of values by social scientists (where they discuss them at all, without reducing valuation behavior to other forms of behavior) takes on a bewildering variety of forms. In the *Guide*, a permissive attitude has been taken: our surveyors of social-science-of-science fields have been given *carte blanche* to report any sort of value focus in the writings surveyed.

### Values, Science, and Technology

This area encompasses three possible concerns: the alleged value neutrality of science and/or technology; the value *of* science (the place of science,

technology, and medicine in contemporary culture); and value issues *in* science. These will be taken up in turn, the first quite briefly.

**Science, Technology, and Value Neutrality.** Especially by scientists and other members of the technical community, but also among the general public, it is widely held that science is "objective" or "value free," or at least "value neutral." A similar claim is often made that "technology is a neutral tool, bad or good only insofar as it is used for some purpose." Neither claim will stand up to criticism, though there is clearly *something* to be said for them.

First, technology: Although the "neutrality" claim is often used in a defensive manner by members of the technical community when technology is under attack, it is hardly consistent with another claim that technologists have few qualms about making—namely, that technology is methodologically distinct from science insofar as it embodies practical applications and social goals. In fact, no particular technology, construed as a technological object, gadget, process, or system, or even an isolated bit of technological knowledge or know-how, can be morally neutral. It was designed or conceived for some purpose, and any such purpose is subject to moral or ethical evaluation. What defenders of the neutrality of technology probably have in mind is that a particular technology designed for one purpose (presumably good) may be used for other purposes and that the designer or producer of an object should not be held responsible for its misuse by someone else. This defense, however, does not get one very far. It is conceivable that someone could design a bit of technology for destructive purposes, and most people would consider a designer at least callous if he or she did not care whether a particular, perhaps technically perfect, product was to be used for good or evil purposes. Defenders of "technological neutrality" seem to intend the phrase to have a positive connotation. They are thus defending technology not as neutral but as good, whatever bad uses others may make of it.

The value neutrality of science is perhaps a slightly trickier question, though the predominant view among philosophers of science—who worry most about such issues—may have swung around recently to the argument that science is not value neutral either.

One version of the "science is value neutral" thesis can be found in views of Arthur Kantrowitz, chief advocate in the United States of the "science court" idea. Kantrowitz believes that the "separation of facts from values can always be made," that "scientists take great pains to separate the factual statements they make from any of their personal values." [10] To this claim Alex Michalos (an author in this volume) has replied: "It is plainly logically impossible to say anything good or bad about anything without saying something that is value laden. It is just literally absurd to pooh-pooh values in the interests of *good* science." Michalos probably speaks for most phil-

osophers of science today when he concludes: "The most one can hope to do," whether by way of science courts or through other means, "is get general agreement about this or that evaluation," [11] whether of facts or of values.

All this is not to say that science is not "objective" in some sense, that there is no ideal of objectivity toward which scientists strive.[12] It is only to say that objectivity, as thus pursued, is itself a value and must be weighed against other values.

**The Place of Science and Technology in Contemporary Culture.** Our next concern is the value *of* science, technology, and medicine, especially in a modern society or culture based on an industrial economy. The concerns of this *Guide to the Culture of Science, Technology, and Medicine* cannot be divorced from the broader social environment of the late twentieth century. One large concern in that context is what might be called the "questioning of science" movement. In the early 1960s there was heated discussion in intellectual circles over the "two-cultures" controversy, especially as brought to public attention in 1958 by C. P. Snow. The late 1960s saw this concern transformed into a pro-and-con debate over the value of technology; in the U.S. this debate may be said to have culminated in Robert Pirsig's *Zen and the Art of Motorcycle Maintenance* (1974).[13] Where Snow had been an open advocate of science and technology, Pirsig may be labelled "protechnology," but only in a very limited sense. Many members of the scientific-technical community feel that the 1970s have seen still further erosion in the public attitude toward science and technology, even though opinion polls do not support this view.[14] Facts alleged in support of the alarmist view include: a sharp decline in the rate of increase of U.S. federal spending for research; signs that other countries are rapidly catching up with the U.S. in terms of technological innovation; and increased expression of alarmist views in the mass media by antitechnology opinion leaders.

There are indicators of negative public sentiment about the scientific-technological community: public perceptions of scientists, engineers, and biomedical researchers are often couched in negative terms.[15] Some even maintain that "technique" dominates modern consciousness to the exclusion of every other kind of thinking in a "one-dimensional society." [16] Problems affecting science and technology have been explained as simply a function of "bigness." [17] Others warn that, as science gets bigger, its problems smaller, and competition fiercer, sharp practices and dishonesty can be expected;[18] some claim that they see this trend exemplified in recent celebrated cases of falsification of scientific data. Still others bemoan the fact that "big science" has achieved its current size as a result of military research funding.[19]

Another problem is the apparent failure of professional codes of ethics, especially in medicine and engineering, to protect the public adequately. Medical and psychological experimentation on human subjects is mentioned

below in our list of specific value issues facing the sciences. This remains a problem in spite of the fact that worldwide codes of ethics for medical practitioners and researchers have undergone revision after revision. Within the sphere of the various engineering societies, it has been claimed that codes of ethics are ineffective safeguards—that at times, indeed, they have served as obstacles to protection of the public.[20]

Perhaps the best known among the outspoken critics of the scientific-technological community are authors associated wtih the "Frankfurt school" in Germany. Most influential in the U.S. is the Marxist-revisionist philosopher, Herbert Marcuse; in Europe, Jürgen Habermas is probably more influential. Marcuse's basic critique, most clearly stated in *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society,*[21] has remained substantially the same through numerous revisions.[22] It is primarily a criticism of capitalist technology and of misuses of technology under bureaucratic socialism. Marcuse's fundamental thesis is that technology, a tool in the hands of the ruling class, helps guarantee the enslavement of the masses by its totally alienating rational objectivity. It is his focus on reason-rationality as the culprit that distinguishes Marcuse's thought. The idea of technological rationality—that "technological controls appear to be the very embodiment of Reason for the benefit of all social groups and interests—occurs to such an extent that all contradiction seems irrational and all counteraction impossible." [23] Some of Marcuse's favorite targets are behaviorist psychology as a tool of thought control, and analytical philosophy as the enforcer of the linguistic status quo. The "one-dimensionality" of his title refers to the flattening out of experience in contemporary culture; Marcuse would call it "pseudo-culture."

Marcuse's explanation of contemporary ills is a sort of "devil theory." It is not unlike Jacques Ellul's equally famous attack on "technique" as the enslaving spirit of our age [24] or related attacks on the spirit of the age by existentialist philosophers.[25] Marcuse's Marxist thought became more influential, and more threatening to the science establishment, than the ideas of other intellectuals because it was adopted by "New Left" radicals of the 1960s bent on disrupting, among other things, scientific professional meetings.

The ideas and impact of another critic, Lewis Mumford, have been much more genteel. Although Mumford has been lumped with four others as "the leading antitechnologists" by one protechnology author,[26] this accusation oversimplifies Mumford's complex and subtle thesis. With great erudition, especially in the two-volume study *The Myth of the Machine* (1967) and *The Pentagon of Power* (1970),[27] Mumford mounts an attack on the theory of tool-using as the evolutionarily distinctive character of *Homo sapiens*. Mumford claims to have discovered such a myth recurring throughout history used by powerful rulers who have been willing to organize their subjects into vast machine-like organizations for the efficient attainment of

their own goals. Mumford's analogy between the organization of manpower for the building of the pyramids and that of technical experts involved in getting men to the moon is widely viewed among literary intellectuals as a penetrating insight. Mumford's overall thesis is that this "myth-of-the-machine" organization is usually oriented toward the selfish aims of rulers and, as often as not, toward military victory. Indeed, the other major image that Mumford presents as a description of the dangers inherent in contemporary technology is that of "the pentagon of power." In this respect, his critique shares some characteristics with the views of those who have attacked the "military-industrial-technological complex."

As mentioned, such criticisms have not filtered down to the masses in technological society. Popular culture remains deferential toward technical experts even while it exhibits a receptive attitude toward negative stereotypes of those experts. It is not too much to say that the culture-versus-science/technology debate remains significant today.

**Value Issues in Science and Technology.** Recall some of the value distinctions made earlier: between values, "the good," and motivations; between long and short-range goals; between tactical and strategic policies. These distinctions suggest some of the concrete value issues that arise in science, technology, and biomedicine today.

First and most obvious of the value issues are the moral issues. Some of the most widely publicized cases involving such questions are those associated with bioethics: experimentation on human subjects, both generally (questions of informed consent) and with respect to particular subjects (prisoners, hyperactive children, fetuses); turning off exotic life-preserving devices or allocating them among needy patients; the right to health care; controversies over medical malpractice; and so on.

Engineering ethics may soon catch up with biomedical ethics as a matter of public debate. To date, the most widely discussed ethical problem in engineering has been that of "whistle-blowing": the effort of particular engineers (or applied scientists) to call public attention to what they see as unethical practices on the part of their employers. Other problems that have received attention include the lack of institutional support (for instance on the part of professional societies) for engineering whistleblowers and others who demand support for what they view as ethical behavior; or alleged unethical behavior of particular engineers—for instance in the design process, or in kickbacks to public officials for contracts to do public work projects.[28] In addition, some questions have been raised—particularly by social critics of technology and certain literary figures—about the narrowness of the value system of engineers in an age demanding social responsibility from all the professions.

Another, and entirely different, sort of value concern in the sciences is the vast area of policy decisions with respect to science, technology, and

biomedical research. Every time a policy decision must be made there is a value issue; often there is also a debate over alternatives, or at least the opening for such a debate. Whether the issue is the funding level for the sciences generally; the funding balance between basic and applied science; relative priorities among the physical and life sciences and medical research; questions about the economic payoff of research and development—in all these cases conflicting values are at stake. In each case, some perspective or bit of information from the science-humanities or social-science-of-science disciplines might lead to more enlightened and reasonable discussion.

These are the more obvious value issues in the sciences. There are others as well. Some social science and historical studies in particular have focused on determining the value system(s) of the general scientific-technical community or of particular segments of it. Others have focused on the significant differences between various general social value systems or cultures as those differences impinge on science and technology.

Another less obvious but no less important set of issues revolves around medicine. In some senses medicine is the most "human" of the sciences surveyed here, and it is, of course, an art as much as it is a science. Some of the issues involved in medical science include the values certain cultures place on health; the degree to which the art or practice of medicine ought to be science based; and the relative weight that ought to be assigned to preventive medicine, health care, clinical research, and so-called "basic" biomedical research.

Last among value issues *within* the sciences, there are broad (often tendentious) questions raised about the relationship between science or technology and ideology. There are issues of an "environmental ethic." And there are a number of general social issues to whose solution many people feel science and technology should contribute: world hunger, energy problems, and the like. Direct guidance on all these issues—even help on how to be reasonable with respect to disagreements about them—will not be found in this volume. Still, it is hoped that enough of these issues will have been touched upon so that helpful analogies or extrapolation may be made that carry over to issues not specifically raised. One hoped-for outcome of *A Guide to the Culture of Science, Technology, and Medicine* is a sizable list of researchable topics for future discussion.

## Some Value Issues Not Taken Up in This Volume

Contemporary art and architecture have clearly been influenced by technology and, to a lesser extent, by science. R. Buckminster Fuller is only one—admittedly an extreme example—of many architects influenced by technology, just as Marcel Duchamp is only one of many painters who have used science and technology as explicit themes. Most contemporary abstract painting and sculpture could not have appeared except in an era of high

technology. Certainly an article on the relationship between science and art would seem to belong in a guide to the culture of science. Our task, however, has been to focus large bodies of existing literature on the value aspects of science, and the available material on science and art either is not ample enough or would not blend into the structure of this volume.

Although a study of science and literature would be meaningful for the cultural values aspect of contemporary science, technology, and medicine, that too has been omitted. In this area there is an abundance of material, including not only criticism of science and technology by literary figures and popular social commentators, but also science fiction.

An excellent critical overview of science fiction is provided by Robert Scholes and Eric S. Rabkin in *Science Fiction: History, Science, Vision* (1977).[29] Although Scholes and Rabkin recognize prototypes of science fiction from the time of Galileo on, they agree with most historians in designating Mary Shelley's Frankenstein (1818) as the true beginning of the genre. The major works between that date and the present that they survey include Jules Verne, *20,000 Leagues under the Sea* (1870); H. G. Wells, *The Time Machine* (1895); Yevgeny Zamyatin, *We* (1920); David Lindsay, *A Voyage to Arcturus* (1920); Olaf Stapledon, *Star Maker* (1937); Arthur C. Clarke, *Childhood's End* (1953); Walter M. Miller, Jr., *A Canticle for Leibowitz* (1959); Ursula K. Leguin, *The Left Hand of Darkness* (1969); and John Brunner, *The Shockwave Rider* (1976). Also included are the "Golden Age" authors: A. E. van Vogt, Robert A. Heinlein, Isaac Asimov, and Theodore Sturgeon. In passing, Scholes and Rabkin touch upon science fiction in media other than literature—for example, Stanley Kubrick's film "A Clockwork Orange" (based on Anthony Burgess' novel) and TV's "Star Trek." The authors conclude that "when the most important American novel of the past several years, Thomas Pynchon's *Gravity's Rainbow* (1973), is also a case of straddling the old dividing line between science fiction and general or 'serious' fiction, then it is obvious . . . that the line itself has virtually disappeared." They also make a prediction about the future: "Science fiction will not exist. But the whole shape of literature will have changed." Scholes and Rabkin's overall judgment is this: "The premise upon which this book is based is that a sufficient number of works of genuine merit have been produced in this field to justify its study as an aspect of modern literature as well as an important feature of contemporary culture." [30]

Along with works of science fiction, which are basically optimistic about science and technology, indeed pushing the technological imagination in fantastic directions, there has been from the beginning a steady influence of modern science on literature. A recent bibliographic survey includes items as early as Boccaccio's *Decameron* (protoscience; fourteenth century); numerous nineteenth-century works, including poems by Elizabeth Barrett Browning, Robert Browning, Ralph Waldo Emerson, and Edgar Allen Poe,

and essays by Matthew Arnold and T. H. Huxley; as well as recent works such as Boris Pasternak's *Doctor Zhivago* and Robert M. Pirsig's *Zen and the Art of Motorcycle Maintenance.*[31] Valuable also are Jacob Bronowski's explicit discussions of science and the literary imagination in *William Blake and the Age of Revolution* and *The Identity of Man.*[32]

There is a long history of antiscience and antitechnology literature. Names here include Goethe (though he is not totally antiscience, even in *Faust*), Mary Shelley (again for *Frankenstein*), the popular trio of Aldous Huxley (*Brave New World,* 1932), George Orwell *(1984,* 1949), and Anthony Burgess (*A Clockwork Orange,* 1962), and—perhaps the most popular in the U.S. in recent years—Kurt Vonnegut (*Player Piano,* 1952, and *Cat's Cradle,* 1963), among others.

Contemporary science and technology have also begun to affect writing in general history and philosophy. Some examples are the excellent coverage of science and technology in Daniel Boorstin's *The Americans,*[33] and John Passmore's *Man's Responsibility for Nature: Ecological Problems and Western Traditions.*[34]

Passmore's work should remind us that one of the most significant issues in contemporary culture involving the impact of science and technology is that of ecology and the environment. In this volume a choice had to be made between covering the topic incidentally, noting where the issues have been raised in the various disciplines, and attempting to be comprehensive in a separate article. The decision was to cover environmental issues incidentally, within the state-of-the-field surveys. Perhaps the seed will have been planted for someone else to attempt an encyclopedic survey of science, technology, and the environment.

Two other areas remain that one might expect to find covered here: science, technology, and law; and science and religion.

A number of law-and-environment issues were excluded by the decision not to treat science and the environment comprehensively. With respect to law, science, and technology more generally, quite a few studies have appeared.[35] In 1970, for example, the *Denver Law Journal* published the proceedings of a symposium entitled *The Implications of Science-Technology for the Legal Process,* and a number of other forums and symposia have been conducted. One particular concern has been product liability.[36] With the exception of the well-established field of patent law, this is a new and rapidly changing area that seemed inappropriate for inclusion in this volume, however central the law may be in the culture of a society.

Science-and-religion controversies have had a long history. For centuries, proscience literature made much of the conflict between Galileo and the Church. The conflict was a major subtheme in much Enlightenment literature throughout the West. The nineteenth century ushered in a heyday of science–religion controversies, notably the Huxley-Wilberforce debates on Darwinism and Robert G. Ingersoll's militant atheistic crusade. All these

events and more are surveyed in Andrew Dickson White's *History of the Warfare of Science with Theology in Christendom* (1897).[37] Although these debates continued into the twentieth century, notably in the famous Scopes trial in Tennessee in 1925, much of the sting of the issue had subsided. Perhaps the last major voice in the debate was that of Bertrand Russell, for example in *Religion and Science* (1935).[38] More balanced treatments have been the norm in recent decades, especially the 1970s.[39] Although religion is and is likely to remain a significant part of man's cultural life a survey of the often needlessly emotional science–religion debate seems out of place in the present volume, though some attention is paid to it in chapter 1. A number of religious critiques of technology and technological culture are also included in chapter 5.

Finally, why is there no survey of insiders' views of the value issues facing science and technology? From the beginning, in the planning of this volume, there has been a minority viewpoint insisting that what was to be done could not be done without including representation from the scientific-technical community. The view that prevailed was that the views of scientists, engineers, and biomedical researchers would be included only incidentally—in the state-of-the-field surveys and at the discretion of individual authors. The success of this method must be left to the judgment of the readers of this volume. It has been our hope from the outset that members of the scientific-technological community would be among the users of the volume—not least those who have courses to teach with such titles as "Science and Values," or "Science, Technology, and Society." Perhaps some users will feel the need to supplement the resources here with firsthand statements of scientists, engineers, or biomedical researchers, in order to achieve a balanced view on substantive issues.

## PART II. INTRODUCTIONS TO THE FIELD SURVEYS

The authors of *A Guide to the Culture of Science, Technology, and Medicine* were given two mandates. One was to survey the state of the art in their field. The second was to attempt some integration with the other fields, especially by focusing on value issues in science, technology, and biomedicine. The latter task was ambiguous from the outset. It can be interpreted as involving: a section or sections on value questions, which might then be discussed either directly or in an encylopedic-descriptive fashion; discussions of various sorts scattered throughout a chapter; or even a treatment in terms of the second-level value choices influencing the treatment (or neglect) of particular value issues in certain culture of science fields. Almost predictably, our authors interpreted their instructions in different ways, with all the possibilities mentioned and variations thereon. A comment will be made on these choices in each of the chapter introductions.

A word needs to be said in each case, as well, on the degree of integra-

tion with respect to the other fields—the extent to which the author(s) succeeded in demonstrating possibilities for integration, as well as the objective possibilities that existed for him or her to work with.

Finally, something should be said about the concern that underlay the assembling of this *Guide* from its inception. There is a feeling, for example, that if the history of science is worth anything at all, over and above its own inherent antiquarian value, it may be in helping someone work toward solutions to value issues facing the scientific community. (At various times it has also been valued for other external purposes, including as an introduction to science for nonscience college students.) This view is a variation on the theme that those who are ignorant of history are doomed to repeat its mistakes. In other areas, it is not the value of historical relevance that is emphasized, but the advantages of looking at issues from the height of philosophical generality or, where possible, analyzing value issues empirically, utilizing the methods of the social sciences. In this introduction to the fields, this issue of "relevance"—possibly the primary one for teachers of courses in technology and values, or science and society—will be taken up largely in the single chapter in Part IV, Policy Studies.

## History of Science

Arnold Thackray in his survey of the history of science takes as his principal focus the way in which external social and cultural values have decisively influenced historical studies of science in different ways at different times. His account moves briskly through the "prehistory" of the history of science; his survey proper begins with the nineteenth century.

As Thackray sees the history of science, it was the French, in terms of Auguste Comte and his "positivist" disciples, who supplied the bridge from nineteenth-century historians to the twentieth-century academic profession of the history of science. And the bridge was the work, for the most part, of one man—George Sarton. Thackray surveys the work of Sarton, that of the 1930s Marxists, and what he labels "The Idealist Program" following World War II. In the last category his main focus is the work of Alexandre Koyré, which he says provided the first true "paradigm"—the way of doing history of science for a generation of scholars—in the history of the history of science.

Thackray ends this section with a quick overview of the wide diversity of current professional approaches to the history of science, calling this "the new eclecticism." Up to this point, then, Thackray's account is a values-oriented externalist history of the history of science movement.

He then devotes the second half of his chapter to "some central domains in the history of science," ranging from the social roots of science, to ancient and medieval science studies, to science and religion, and to relations with other fields surveyed in the *Guide*. The bibliography is, relatively

speaking, concise; however, it is a judicious selection that should prove helpful to students and scholars in other fields.

### History of Technology

Carroll Pursell's survey of the history of technology emphasizes two things: the variety of people working in the field—economic historians, social historians, scholars in American Studies programs, "industrial archaeologists," as well as "professional" historians of technology—and the tendency of professional historians of technology to differentiate themselves from their predecessors by focusing on the social as well as the mechanical aspects of technology. According to his outline, the field came into being as a result of the interests of students of industrial history in Britain (the Newcomen Society for the Study of the History of Engineering and Technology, founded in 1919) and of engineering educators in the United States (the Society for the History of Technology, founded in 1958).

In this section Pursell emphasizes the diversity of history of technology approaches—internal history of technology, work stressing business strategies and economic change, the biographies of famous inventors or entrepreneurs combined with histories of individual industries; and at least two types of social history of technology, institutional and intellectual.

The second major portion of Pursell's chapter is devoted to problem areas of special interest in the history of technology: medieval technology, the professionalization of engineering, and women and technology, among others. For the most part, this section is reportorial and bibliographic.

In the final third of his survey, Pursell discovers the relationship of history of technology to other fields—history of science, general history, and so on—and, in a brief section, the relation of history of technology to value issues. Here Pursell suggests that *all* of history of technology is inherently value-oriented because of the nonneutrality of technology.

### History of Medicine

Gert Brieger's survey of the history of medicine, like Pursell's on the history of technology, is an insider's survey. It is punctuated occasionally with flashes of Brieger's wry wit or the gentle needling of his colleagues. The "insider" aspect shows up in the authoritative judgments of someone who has been at the intellectual center producing much of the history of medicine scholarship on which he reports.

Brieger moves meticulously through the entire range of approaches to history of medicine, old and new. There are particularly good treatments of the social history of medicine in general, the social history of hospitals, social history work on psychiatry, and oral history. Brieger is also illuminating on the relationship of the history of medicine to other fields, especially