Philosophy of Science: A Subject with a Great Future

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Among philosophers of science nearly a century ago the dominant attitude was that (in Rudolph Carnap's words) philosophy of science was "like science itself, neutral with respect to practical aims, whether they are moral aims for the individual, or political aims for a society." The dominant attitude today is not much different: our aim is still to articulate scientific rationality, and our understanding of that rationality still excludes the moral and political. I contrast this with the growing entanglements within the sciences of the ethical and the epistemic, and I suggest ways in which philosophers of science can usefully respond.

1. Introduction. If we try to characterize in a general way what it is we philosophers of science do, we typically come up short. We frequently find that we have more in common with colleagues in the various sciences, or the history of science, or the sociology of science, or cognitive science, or social epistemology, or the history of philosophy, or some other area instead than we have with each other. Interdisciplinarity seems to be our strength. But our interdisciplinarity has its limits. Few of us have much in common, in terms of academic pursuits, with those who regularly analyze science from a moral or political point of view, still less with those who, from a moral or political point of view, actively endorse some approaches in science and not others. How research funds should be allocated, priorities set, research organized, results communicated and applied, and accountability maintained—how all of this should (morally or politically should) be done—is seldom what professionally engages our attention, even though policy decisions about all of this have profound effects on what does concern us. It is as if Rudolf Carnap's description of the dominant attitude in philosophy of science nearly a century ago was a description of us:

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> All of us in the [Vienna] Circle were strongly interested in social and political progress. . . . But we liked to keep our philosophical work separated from our political aims. In our view, logic, including applied logic, and the theory of knowledge, the analysis of language, and the methodology of science, are, like science itself, neutral with respect to practical aims, whether they are moral aims for the individual, or political aims for a society. (Carnap 1963, 23)

But much has changed since the early twentieth century. Research in the history, philosophy, and sociology of science has shown that science itself is shot through with values; very little of it is morally and politically neutral. So a moral/political approach toward it has been rendered much more natural. Moreover, recent events disclose a potent mix of moral and religious and political and economic interests shaping science more vigorously than at almost any time in the recent past: witness the current furor over the "politicization" and "commercialization" of science. So a moral/political approach toward science has now been rendered much more urgent. Although we have, for the most part, failed to take up this approach, the time is right to do so. But how? How can our role as philosophers of science be thought to encompass such an approach?

2. A Glance at the Past. It was the middle of the twentieth century when Carnap wrote his reminiscence of the Vienna Circle, and by then philosophy of science had come into its own as a professional discipline. Indeed, by then new academic departments and privately endowed centers had formed that were devoted exclusively to philosophy of science, new philosophy of science journals and conference series and book series were launched, and government support for research was expanding through such sources as the National Science Foundation (for more details see Howard 2003). In addition, philosophy of science by then enjoyed increasing prestige within traditional philosophy departments and a preeminent place among the various science studies fields. All this prominence achieved by philosophy of science was doubtless connected, at least in part, to the distinctive goal philosophy of science had adopted. Unlike other areas of philosophy such as ethics or epistemology or metaphysics, philosophy of science sought to engage with and contribute to *science*, then (and probably still) considered the most impressive, most progressive, most demanding of human endeavors. And unlike other science studies fields such as history of science and sociology of science—which also engaged with science—philosophy of science sought not simply to describe science but to articulate and even improve upon what lay at the very heart of its success, scientific rationality itself.

As impressive as the goal of philosophy of science was, however, the

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mode of its pursuit left something to be desired. Indeed, at mid-century, as is well known, only the logical aspects of science were thought relevant to scientific rationality—only those logical aspects, in fact, related to Hans Reichenbach's context of justification. Articulating and improving upon scientific rationality meant reconstructing science using the modes of conceptualization provided by formal logic and empiricist epistemology—reconstructing science in such a way as to maximize the virtues considered essential to those modes of conceptualization. This was, of course, the understanding of philosophy of science's goal associated most famously not only with Reichenbach but also with Rudolf Carnap and Carl Hempel. Thus, scientific theories were represented as axiom systems partially interpreted by an observational language itself interpreted on the basis of observation. Explanations invoking such theories were represented as the logical derivation of the statements to be explained (the "explananda") from the theories and statements of initial conditions (the "explanans"). The assessment of these theories was represented as the logical derivation of observation statements ("predictions") (from the theories in conjunction with statements of initial conditions) and the comparison of those predictions with statements describing the results of observation or experiment. And so on. But, as Thomas Kuhn, Paul Feyerabend, Imre Lakatos, Stephen Toulmin, and a host of others made especially clear, those logical aspects of science, though they were surely relevant to an understanding of scientific rationality, were far from the whole story. Indeed, the critics suggested that those logical aspects provided very little of the story—that what philosophy of science was offering as an account of scientific rationality was of surprisingly little relevance to actual science.

No matter. By the end of the twentieth century the mid-century critics and those they influenced had more than compensated for the first lean offerings of professional philosophy of science. No longer was scientific rationality thought to be confined merely to Reichenbach's context of justification; it was now understood to encompass as well the abductive and other reasoning processes that populated his context of discovery. Nor was scientific rationality confined any longer to *logic*, whether of discovery or justification. Indeed, social factors such as competition and cooperation among scientists and particular patterns of consensus and dissensus were found to contribute to scientific success, and it became possible to speak of the rationality of various modes of community organization and community practice as well as the rationality of various modes of individual behavior. Even the more material aspects of science, such as scientific instrumentation and scientific modeling, were found to relate to scientific rationality since they embedded within them scientific knowledge and thereby contributed to the development of new knowledge. And the old questions of theory structure and theory validation were

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treated in new ways, ways that were informed by historical accounts of the temporally extended research programs that generated such theories and determined the conditions of their acceptance or rejection. By the end of the twentieth century, in short, articulating and improving upon scientific rationality was found to require involvement with a great many aspects of science, historical and social and material as well as logical, and the resources from a variety of fields—including the history of science, the sociology of science, cognitive science, social epistemology, and the history of technology—were required to do this well. But by century's end, articulating and improving upon scientific rationality was *not* found to require involvement with the *ethical* aspects of science, and hence no resources from such fields as ethics or political philosophy or public policy were required to do philosophy of science well. True, feminist philosophers of science were speaking a great deal about the ethical aspects of science and how they relate to scientific rationality, and philosophers of biology were occasionally taking up such topics as the ethical implications of the genome project or the status of creation science or the political as well as conceptual and empirical problems associated with sociobiology. But for the rest, to quote from a 1996 essay by Phillip Kitcher and Nancy Cartwright, the ethics of science was "virtually unexplored territory" (Kitcher and Cartwright 1996, 149).

Meanwhile, in the sciences—that which philosophy of science was supposed to be about—new or newly revised ethical codes were proliferating by century's end. On the American scene, the American Physical Society adopted its "Guidelines for Professional Conduct" in 1991 (updated and expanded in 2002), the American Chemical Society adopted "The Chemist's Code of Conduct" in 1994, the Society for American Archaeology adopted the "Principles of Archaeological Ethics" in 1996, the American Sociological Association approved its revised "Code of Ethics and Policies and Procedures" in 1997, the American Society for Biochemistry and Molecular Biology approved its "Code of Ethics" in 1998, and the American Psychological Association adopted the most recent version of its "Ethical Principles of Psychologists and Code of Conduct" in 2002—to cite just a few examples. On the international scene there were, for example, the "Uppsala Code of Ethics for Scientists," published in 1984 and considered a basis for later international guidelines; "The Toronto Resolution" of 1991, whose purpose was to create a common moral framework worldwide for the conduct of research; and the "Code of Conduct for Scientists," called for by the 1999 World Conference on Science organized by UNESCO and the International Council for Science, to be prepared by 2007. All these codes acknowledged scientists' multiple responsibilities—for example, to their individual disciplines and to science in general; to society and to the environment; to their employers, em-

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ployees, coworkers, and students; and to their human, animate, and even inanimate (e.g., archaeological) subjects of investigation. All these codes thereby acknowledged, whether explicitly or implicitly, potential conflicts arising from scientists' multiple responsibilities—conflicts between scientists' epistemic responsibility to advance science and their ethical responsibility to serve the public good, for example; or conflicts between scientists' epistemic responsibility to obtain and disseminate particular kinds of information and their ethical responsibility to protect the subjects of their investigations from harm; or conflicts between scientists' epistemic as well as ethical responsibility to share information with other scientists and their ethical responsibility to safeguard the proprietary information of their employers. All these codes, as a result, illustrated the entanglements in science of the ethical and the epistemic. For scientists at century's end, in short, unlike for philosophers of science, articulating and improving upon scientific rationality did obviously require involvement with the ethical aspects of science.

3. Challenges of the Present. If the ethical codes proliferating at century's end pointed toward a fuller understanding of scientific rationality, they were also hampered by a variety of weaknesses, most notably vagueness and incompleteness. Consider, for example, the issue of fraud. A growing concern over fraud in science was surely one of the factors that motivated at least many of the American codes of ethics that appeared at century's end. There was, after all, a succession of well-publicized cases of "scientific misconduct" in prominent U.S. research institutions. It started in the 1970s with the case of William Summerlin, chief of transplantation immunology at Sloan-Kettering, who claimed he could transplant, even across species, corneas, glands, and skin that would normally be rejected; he was discovered only after 3 years when a lab assistant noticed that the black "skin graphs" were drawn on with a marker (Judson 2004). The publicized cases of misconduct even included the so-called Baltimore Affair, in which a paper, coauthored by Nobel Prize winner and soon-to-be President of Rockefeller University David Baltimore, was suspected of suppressing negative evidence and even making use of fabricated evidence; the case took 10 years to settle, involved investigations by the National Institutes of Health and two universities as well as Congress, and is still controversial (see, e.g., Kevles 1998 and Judson 2004). And there was a succession of studies suggesting that the varieties and extent of the misconduct went far beyond the public cases. *Betrayers of the Truth: Fraud and Deceit in the Halls of Science*, for example, written by *Science* news reporters William Broad and Nicholas Wade (1982), provided the first substantive overview of the extent of scientific misconduct. *Stealing into Print: Fraud, Plagiarism, and Misconduct in Scientific Publishing,* by science policy an-

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alyst Marcel LaFollette (1992), analyzed scientific publication practices, including peer review and journal editorial policies, and the ways in which they allowed for scientific misconduct. And *Impure Science: Fraud, Compromise, and Political Influence in Scientific Research* by economist Robert Bell (1992) drew on case studies from the National Institutes of Health, the National Science Foundation, and the Department of Defense to argue that contemporary U.S. science was being corrupted by money and politics, that is, by its "patronage" system. There were also other kinds of studies—for example, the Acadia Institute Project on Professional Values and Ethical Issues in the Graduate Education of Scientists and Engineers (see Swazey, Anderson, and Louis 1993), funded by the National Science Foundation, which focused on the academic research environment itself and found that, of the 2,000 doctoral candidates and 2,000 faculty surveyed in 99 of the largest graduate departments in chemistry, civil engineering, microbiology, and sociology in the United States, 50% of the faculty and 43% of the students reported direct knowledge of at least two types of misconduct in their laboratories ranging from faking research results to withholding results from competitors, and 53% of the students and 26% of the faculty revealed that they were unlikely to report such misconduct for fear of reprisals. All this scientific misconduct played an important role in motivating the proliferation of ethics codes in the sciences at century's end—codes at least one of whose purposes was to prevent the misconduct.

But the mode of prevention was frequently very flimsy indeed. Take, for example, the American Chemical Society's "Chemist's Code of Conduct" (American Chemical Society 1994). It maintains that chemists have responsibilities to nine entities—the public, the science of chemistry, the profession, the environment, employers, employees, students, associates, and clients, and regarding the profession in particular it maintains that "conflicts of interest and scientific misconduct, such as fabrication, falsification, and plagiarism, are incompatible with this Code." But it leaves completely unexplained exactly what "fabrication, falsification, and plagiarism" are. For example, is the common practice of "gift authorship," in which the names of senior researchers are included on papers that they had no part in producing just because the work was done in their labs, funded by their research grants—is this practice *plagiarism*—the senior researchers taking credit for work that is not really theirs? Or is it rather *exploitation* of the students or associates whose work it is—which is incompatible with other parts of the "Chemist's Code" than the part quoted, the parts that specify a chemist's responsibilities to students and associates rather than the profession? Or is the practice of gift authorship, instead, something laudable, part of promoting the "professional development" of students, helping them to get ahead by associating their names with

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the names of established scientists—something *supported* by the code? Is gift authorship, in short, "intellectual corruption" (Richard Lewontin's [2004] description), part of the "culture of fraud" that is science today (Horace Judson's [2004] description)? Or is it, as many other scientists claim, just "standard practice," harmless and acceptable (see LaFollette 1992, 100).

Or consider another part of the "Chemist's Code of Conduct" and another motivation for at least some of the new ethics codes at century's end. Concern over global problems—concern over ever-mounting threats to the environment, ever-mounting threats to public health, ever-mounting threats to world peace—concern over these problems also played a role in the appearance of some of the ethics codes. The expectation had always been that science would solve such problems, but, by the end of the twentieth century, there was a growing sense that science had failed to solve them and may even have made them worse.[1] As one of the background papers for the 1999 World Conference on Science, the conference that was to produce a new international code of ethics for scientists, proclaimed:

> Today . . . science suffers from a serious image problem. In large parts of the world, people no longer conceive of science as being essentially a benefactor of humanity, nor do they readily associate science with the classical quest to develop a more enlightened civilization. Trust in the ethical integrity and responsibility of scientists is declining partly to be replaced by suspicion and fear of abuses of various kinds. . . .
>
> The present state of affairs calls for a powerful statement about the ethical responsibilities of science towards society and present or future generations, and towards the environment. (International Council for Science's Standing Committee on Responsibility and Ethics in Science 1999)

But all that the "Chemist's Code of Conduct" (American Chemical Society 1994) says about the ethical responsibilities of chemistry to society and present and future generations is: "Chemists have a professional responsibility to serve the public interest and welfare and to further knowledge of science. Chemists should actively be concerned with the health and welfare of co-workers, consumers and the community. Public comments

1. Global warming formed a particularly painful example. During the last decade of the twentieth century and the first few years of the twenty-first century, the United States spent upward of $25 billion on global climate system research as a basis for creating appropriate climate policy, but it has yet to take any meaningful action on such policy (Sarewitz 2006). The problem, meanwhile, keeps getting worse.

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on scientific matters should be made with care and precision, without unsubstantiated, exaggerated, or premature statements." And all that the Chemist's Code of Conduct says about the ethical responsibilities of chemistry to the environment is: "Chemists should understand and anticipate the environmental consequences of their work. Chemists have responsibility to avoid pollution and to protect the environment." But the Code leaves completely undefined what all these responsibilities amount to, these responsibilities to serve the public interest and welfare, avoid pollution, and protect the environment, and it is important to remember that the Chemist's Code also covers the ethical responsibilities of chemists to their employers—who, of course, include, among others, manufacturers of petrochemicals and the pharmaceutical industry. These responsibilities to employers read: "Chemists should promote and protect the legitimate interests of their employers, perform work honestly and competently, fulfill obligations, and safeguard proprietary information" (American Chemical Society 1994).

Other ethical codes within the sciences have comparable problems. The American Physical Society's (2002) "Guidelines for Professional Conduct," for example, though far more precise in dealing with the issues of gift authorship and other kinds of scientific misconduct, never even mention physicists' responsibilities to society or future generations or the environment or even physicists' responsibilities to their employers, many of whom, of course, are involved in the development and deployment of military weaponry. In fact, the only responsibility of physicists noted in their code is their responsibility to *science*, physics in particular:

> The Constitution of the American Physical Society states that the objective of the Society shall be the advancement and diffusion of the knowledge of physics. It is the purpose of this statement to advance that objective by presenting ethical guidelines for Society members.
>
> Each physicist is a citizen of the community of science. Each shares responsibility for the welfare of this community. Science is best advanced when there is mutual trust, based upon honest behavior, throughout the community. Acts of deception, or any other acts that deliberately compromise the advancement of science, are unacceptable. (American Physical Society 2002)

The "Code of Ethics" of the American Society for Biochemistry and Molecular Biology (1998), on the other hand, *does* acknowledge other responsibilities besides the responsibility to science—for example, the responsibility to the public "to promote and follow practices that enhance the public interest or well-being" and the responsibility to trainees "to create and maintain a working environment that encourages cultural di-

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versity." Of course, these responsibilities are, again, unhelpfully vague, but the inclusion of the responsibility to encourage cultural diversity is still noteworthy. Or rather, its *absence* from *other* ethics codes is noteworthy given the prominence accorded the lack of diversity in the sciences at century's end. The examples go on and on.

4. Hopes for the Future. The needs that have motivated the ethics codes in the sciences are not being met. If anything, they are getting more pressing. But scientists tend to be reluctant to be policed by outsiders and outsiders, for their part, tend to be reluctant to police science (for examples of this, see Goodstein 1995). The ethics codes, by contrast, have been constructed by scientists and are enforced by scientists. What's more, they—some of them—have been revised when inadequacies have been uncovered,[2] and they can be revised again. So the ethics codes ultimately represent scientists' policing themselves. But the ethics codes tend to be inadequate. Helping to make them adequate thus becomes an important project, not only because the ethics codes are scientists' own responses to their own serious problems but also because adequate ethics codes define the goals to which all other responses are directed. For example, sociological research into the structural conditions (e.g., funding, publication, and science journalism practices) that encourage scientific misconduct and resulting policy recommendations for changing those structural conditions to discourage such misconduct all depend on an understanding of what constitutes appropriate and inappropriate scientific conduct and it is this that adequate versions of ethics codes are intended to supply.[3] They also

2. For example, the American Psychological Association's "Ethical Principles of Psychologists and Code of Conduct" has been revised nine times since 1953. See American Psychological Association (2002).

3. Against the charge (see, e.g., Franzen, Rödder, and Weingart 2007) that everyone already knows what constitutes appropriate and inappropriate scientific conduct it must be noted that everyone is learning this neither from the generally vague ethics codes now available nor from professors and mentors and coworkers who, according to the Acadia study previously mentioned (Swazey et al. 1993) as well as more recent studies (e.g., Martinson, Anderson, and De Vries 2005), are frequently poor models of appropriate scientific conduct. Note, also, that the category systems of misconduct used by these studies are themselves contested (see, e.g., Wadman 2005). And when we remember that "appropriate scientific conduct" covers much more than nonfraudulent scientific conduct, that it also covers, for example, research activities genuinely beneficial to society, the need for adequate ethics codes to counteract what everyone learns from prevailing practices becomes even more apparent. Small wonder that "The Toronto Resolution" (see Faucett 1993) calls for adequate ethics codes to be "widely disseminated through the school and university curricula, to educate rising generations, as well as practicing scientists and scholars, about their emerging responsibilities."

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provide a basis for funding decisions and serve important pedagogical functions for both scientists and the public at large.

Helping to make the ethics codes in the sciences adequate is thus an important project—an important *normative* project, one that looks deeply into not only the aims and attendant responsibilities that scientists do set for themselves, both individually and collectively, but also the aims and responsibilities scientists ought to set for themselves. It is, moreover, an important epistemic as well as ethical project: helping to make the ethics codes adequate responds to needs that are both epistemic and ethical. Scientific fraud, for example, is not only unethical but also a serious threat to the validity of accepted scientific knowledge. Exclusionary practices within the scientific community—practices that exclude women and minority men from equal opportunities with white men, for example—are not only unethical—unjust—but are also epistemically damaging since they decrease the pool of available talent and, as the work of women scientists during the last few decades amply demonstrates, also tend to leave in place the biases associated with the group that excludes. The failure of scientists to respond to the legitimate needs of society is not only unethical—an unfair recompense for the support society has lavished on science—but is also a threat to society's continued support of science and thereby to science's continued epistemic success. And so on. And, of course, looking deeply into the aims that scientists ought to set for themselves involves epistemic considerations, such as the feasibility of certain kinds of endeavors,[4] as well as ethical considerations, such as the social value of those endeavors. The upshot: helping to make the ethics codes in the sciences adequate connects to traditional normative and epistemic concerns of philosophy of science as much as it departs from those concerns—or better, discloses a whole new set of connections to those traditional normative and epistemic concerns, ethical connections. If it is time philosophers of science integrate the ethical into our conception of scientific rationality, exploring how to make the ethics codes in the sciences adequate is an excellent place to start.

Nearly four decades ago Paul Feyerabend wrote an essay entitled "Philosophy of Science: A Subject with a Great Past" in which he bemoaned the uselessness of the then-fashionable logical empiricism and went on to urge philosophers of science to pursue a very different kind of philosophy, one not only relevant to science but also fearless to criticize and even transform that science rather than conform to it. For this purpose Feyerabend suggested that philosophers engage in a detailed study of primary sources in the history of science, at least those primary sources in which

4. The realism/antirealism controversy in philosophy of science illustrates such epistemic considerations. See, e.g., van Fraassen 1980 and Kourany 2000.

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philosophy was closely involved with the science that was done and helped to shape its development: "It is to be hoped that such a concrete study will return to [philosophy of science] the excitement and usefulness it once possessed" (Feyerabend 1970). Now, decades later, there is a need once again to bemoan the uselessness of philosophy of science and urge philosophers of science to criticize and even transform science rather than conform to it. This time, however, the need is to be met by ethical study, not historical—by broadening our conception of scientific rationality to encompass the ethical aspects of science, by acknowledging the inextricable interconnections of the ethical and the epistemic. It is to be hoped that, by broadening our conception of scientific rationality in this way, we will indeed be able to return to philosophy of science the excitement and usefulness it once possessed—if not at the time of Feyerabend's Galileo, then at least at the time of the Vienna Circle's Neurath and Frank.

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