Scientific Method in Brief

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Ethics and responsibilities

This chapter presents an exceedingly brief account of philosophical and professional ethics. It is essential and unavoidable for science and technology to be guided and constrained by an ethical vision.

The main topic, having the longest section, is science's professional ethics. All position papers on science recognize science's ethics as an essential item in the science curriculum. But that section needs to be preceded by a shorter section on philosophical ethics, which provides the broader context needed to make professional ethics meaningful.

Philosophical ethics

The ideas on philosophical ethics presented here are drawn from three exceptional books, two old and one recent: Caldin (1949), MacIntyre (1988), and Sandel (2009). Edward Caldin was a lecturer in chemistry at the University of Leeds. Alasdair MacIntyre has taught philosophy at the University of Oxford, University of Essex, Notre Dame University, Duke University, and several other universities, and is a past president of the American Philosophical Association. Michael Sandel teaches a large and popular course on ethics at Harvard University.

The first several pages of MacIntyre (1988) emphasize the challenges and controversies surrounding ethics. Most obviously, ethics raises perplexing questions, such as: "Does justice permit gross inequality of income and ownership? Does justice require compensatory action to remedy inequalities which are the result of past injustice, even if those who pay the costs of such compensation had no part in that injustice? Does justice permit or require the imposition of the death penalty and, if so, for what offences? Is it just to permit legalized abortion? When is it just to go to war?" People disagree.

But deeper than different answers are different reasons for those answers (and, indeed, people can even happen to reach the same answers for radically different reasons). People hold different worldviews.

Furthermore, besides conflicts between persons holding different worldviews, MacIntyre astutely observed that there are often inconsistencies and conflicts within a given individual. “For what many of us are educated into is, not a coherent way of thinking and judging, but one constructed out of an amalgam of social and cultural fragments inherited both from different traditions from which our culture was originally derived (Puritan, Catholic, Jewish) and from different stages in and aspects of the development of modernity (the French Enlightenment, the Scottish Enlightenment, nineteenth-century economic liberalism, twentieth-century political liberalism). So often enough in the disagreements which emerge within ourselves, as well as in those which are matters of conflict between ourselves and others, we are forced to confront the question: How ought we to decide among the claims of rival and incompatible accounts of justice competing for our moral, social, and political allegiance?” (MacIntyre 1988:2).

As if perplexing questions and external and internal conflicts are not enough, MacIntyre also noted the severe limitations of academic ethics. “Modern academic philosophy turns out by and large to provide means for a more accurate and informed definition of disagreement rather than for progress toward its resolution. Professors of philosophy who concern themselves with questions of justice and of practical rationality turn out to disagree with each other as sharply, as variously, and, so it seems, as irremediably upon how such questions are to be answered as anyone else” (MacIntyre 1988:3).

MacIntyre (1988:3) realized that some academics proffer “a genuinely neutral, impartial, and, in this way, universal point of view, freed from the partisanship and the partiality and onesidedness that otherwise affect us.” But, inevitably, such an offering is itself “contentious in two related ways: its requirement of disinterestedness in fact covertly presupposes one particular partisan type of account of justice, that of liberal individualism, which it is later to be used to justify, so that its apparent neutrality is no more than an appearance, while its conception of ideal rationality as consisting in the principles which a socially disembodied being would arrive at illegitimately ignores the inescapably historically and socially context-bound character which any substantive set of principles of rationality, whether theoretical or practical, is bound to have” (MacIntyre 1988:3–4). We inhabit a culture with rival ethics and competing rationalities and worldviews, so there is no “neutral” position. That is just the way things are.

The best way to ground ethics would be to find and work within a true worldview rather than to labor with a thin least common denominator that also accommodates numerous false and incompatible worldviews. But, again, which worldview is true is not this book’s question. For better or for worse, a related question is inescapable: Given the reality of lack of worldview consensus in the scientific community and the larger society, what attitude should scientists take toward discussions of ethical issues? Thankfully, this question about attitude is somewhat more manageable than the larger question about truth.

The final two pages of Sandel (2009:268–269) are helpful. He recognized the very real difficulties with discourse about ethics. "Some consider public engagement with questions of the good life to be a civic transgression, a journey beyond the bounds of liberal public reason. Politics and law should not become entangled in moral and religious disputes, we often think, for such entanglement opens the way to coercion and intolerance. This is a legitimate worry. Citizens of pluralist societies do disagree about morality and religion. Even if, as I've argued, it's not possible for government to be neutral on these disagreements, is it nonetheless possible to conduct our politics on the basis of mutual respect?" His prescription followed.

> The answer, I think, is yes. But we need a more robust and engaged civic life than the one to which we've become accustomed. In recent decades, we've come to assume that respecting our fellow citizens' moral and religious convictions means ignoring them (for political purposes, at least), leaving them undisturbed, and conducting our public life – insofar as possible – without reference to them. Often, it means suppressing moral disagreement rather than actually avoiding it. This can provoke backlash and resentment. It can also make for an impoverished public discourse, lurching from one news cycle to the next, preoccupied with the scandalous, the sensational, and the trivial.
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> A more robust public engagement with our moral disagreements could provide a stronger, not a weaker, basis for mutual respect. Rather than avoid the moral and religious convictions that our fellow citizens bring to public life, we should attend to them more directly – sometimes by challenging and contesting them, sometimes by listening to and learning from them. There is no guarantee that public deliberation about hard moral questions will lead in any given situation to agreement – or even to appreciation for the moral and religious views of others. It's always possible that learning more about a moral or religious doctrine will lead us to like it less. But we cannot know until we try.
>
> A politics of moral engagement is not only a more inspiring ideal than a politics of avoidance. It is also a more promising basis for a just society. (Sandel 2009:268–269)

Sandel concluded that precious little ethics can be defended within the bounds of what he terms "liberal public reason." Echoing MacIntyre, conceptions of both ethics and reason are controversial, so there is no neutral, public reason. MacIntyre's resolution, which Sandel (2009:208–243) respected, is so-called communitarian ethics. As its name would suggest, communitarian ethics locates persons within a community or tradition providing resources for developing ethics. Sandel (2009:221) quoted MacIntyre, "I can only answer the question 'What am I to do?' if I can answer the prior question 'Of what story or stories do I find myself a part?'" In this book's terminology, such stories implicate one's worldview. Often a person's worldview prompts obligations, responsibilities, and even sacrifices beyond the basic requirements found in public discourse and civil law.

Communitarian ethics is agreeable to Caldin's view that science by itself cannot initiate or guarantee the good life. But presuming that life experiences have already shown the dignity of persons and the value of reason, science can stimulate and strengthen those factors contributing toward the good life:

We have argued that man has a certain definite nature, with definite potentialities; he is rational, capable of knowing truths and desiring goods, and of acting accordingly; he is also an animal, equipped with animal instincts; and he is a social being, not an isolated individual. . . . Now, in ethics as in metaphysics, we may find a key in considering the actualizing of potentialities. . . . Truthfulness and wisdom are ends befitting a being equipped with intellect; love and self-discipline become a being equipped with a rational appetite for the good; justice, honesty, faithfulness, altruism and mutual love are fitting in human beings because they are also social by nature. . . . The good life is concerned with pursuing ends consonant with our nature; with realising, fulfilling, what we are made for; this determines the moral qualities that men and society should aim at, and so gives us the guiding principles for action both at the individual and social planes. . . .

Many people have been led to think that the procedure of natural science is the royal road to truth in every field, and that what cannot be proved by science cannot be true. . . . Such a use of the great prestige of science to-day would, however, fail unless science were pursued as part of a pattern of wider scope, and the limitations of its method recognized. For science will not give us the conceptions that we need in dealing with the fundamentals of life – the great conceptions of personality, justice, love, for instance, must be drawn from elsewhere; moreover, science gives us only part of the mental training for using them. Again, although science, given its appropriate setting, plays its part in developing both intellectual and moral virtues, it does not originate those virtues; it only supports them where they exist already. It favors an intellectual climate where persons are respected; but it does not create these values, it presupposes them. . . . In relation to the great social purposes – such as peace, justice, liberty – science is instrumental; it is not normative, does not lay down what ought to be. If scientific method is applied outside its own field, if the attempt is made to use one rational method for work appropriate to another, the result is always confusion and, at worst, disaster. To make its full contribution in society, science must respect the fields of other studies; conversely, it relies upon those studies being in a healthy condition. In concrete terms, this means that a scientist who is ignorant of philosophy, history, art and literature, will not be able to speak for reason with the power that he should. . . .

Science and its technical application can both be integrated into the pattern of the good life; science forms an integral part of the good life for a scientist, and the applicability of science can be turned to good account. Potentially, then (whatever we may think of it in practice), natural science is an ally of wisdom and good living. . . . The battles against disease, destitution and ignorance are always with us, and science is a powerful ally; perhaps the most necessary ally after love and understanding and common sense" (Caldin 1949: 138, 6, 169, 159, 175, 161)

Caldin's perspective also agrees with the position of the American Association for the Advancement of Science. "Nor do scientists have the means to settle issues concerning good and evil, although they can sometimes contribute to the discussion of such issues by identifying the likely consequences of particular actions, which may be helpful in weighing alternatives" (AAAS 1989:26).

Professional ethics

The National Academy of Sciences, National Academy of Engineering, and Institute of Medicine co-published *On Being a Scientist: A Guide to Responsible Conduct in Research* (NAS 2009). This section draws principally from this little book that provides superb practical guidance. However, it provides meager philosophical grounding, perhaps because there is little consensus to appeal to, which is why the preceding section drew upon other resources. The opening comments express this book's nascent philosophical ethics and its motivation.

> The scientific enterprise is built on a foundation of trust.... When this trust is misplaced and professional standards of science are violated, researchers are not just personally affronted—they feel that the base of their profession has been undermined. This would impact the relationship between science and society....
>
> In the past, beginning researchers learned...how the broad ethical values we honor in everyday life apply in the context of science.... This assimilation of professional standards through experience remains vitally important.
>
> However, many beginning researchers are not learning enough about the standards of science through research experiences.... The guide *On Being a Scientist* explores the reasons for specific actions rather than stating definite conclusions about what should or should not be done in particular situations.... Since all researchers need to be able to analyze complex issues of professional practice and act accordingly, every course in science and related topics and every research experience should include discussions of ethical issues....
>
> Researchers have three sets of obligations that motivate their adherence to professional standards. First, *researchers have an obligation to honor the trust that their colleagues place in them*.... Second, *researchers have an obligation to themselves*.... Third, because scientific results greatly influence society, *researchers have an obligation to act in ways that serve the public*.... By considering all these obligations—toward other researchers, toward oneself, and toward the public—a researcher is more likely to make responsible choices.... Research is based on the same ethical values that apply in everyday life, including honesty, fairness, objectivity, openness, trustworthiness, and respect for others. (NAS 2009:ix–x, xv–xvi, 2–3)

Ethical violations occur with different degrees of severity. The most serious are termed "scientific misconduct." The US government recognizes three kinds of misconduct: fabrication, falsification, and plagiarism. "All research institutions that receive federal funds must have policies and procedures in place to investigate and report research misconduct, and anyone who is aware of a potential act of misconduct must follow these policies and procedures" (NAS 2009:3).

IEEE

IEEE CODE OF ETHICS

WE, THE MEMBERS OF THE IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. to accept responsibility in making decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;
2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
3. to be honest and realistic in stating claims or estimates based on available data;
4. to reject bribery in all its forms;
5. to improve the understanding of technology, its appropriate application, and potential consequences;
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;
9. to avoid injuring others, their property, reputation, or employment by false or malicious action;
10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Approved by the IEEE Board of Directors | February 2006

Figure 12.1 The IEEE code of ethics of the Institute of Electrical and Electronic Engineers. As the world's largest professional association for the advancement of technology, their code of professional ethics is representative of those for many scientific and technological organizations. (Reproduced with kind permission from the IEEE. © 2011 IEEE)

Lesser violations are termed "questionable research practices." Although not misconduct at the federal level, such practices are strongly discouraged and may warrant penalties at a scientist's local institution.

Most professional societies of scientists and technologists have a published code of ethics. Figure 12.1 shows a representative one. It is from the

Institute of Electrical and Electronic Engineers (IEEE), the world's largest such society.

Note the rudimentary but crucial philosophical ethics in the preamble, "in recognition of the importance of our technologies in affecting the quality of life throughout the world and in accepting a personal obligation to our profession, its members and the communities we serve . . . ". This code contains a combination of ethical values applicable to everyday life, and other values more distinctively characteristic of the scientific enterprise. Mastery of scientific method is imperative for meeting this code of ethics, especially the third item, "to be honest and realistic in stating claims or estimates based on available data" (as well as the fifth through seventh items).

Besides professional ethics, there is also a role for personal ethics. Conspicuously absent from this IEEE code of ethics for engineers is any statement about military research. Nonetheless, the personal ethics emerging from an individual's experiences and background and worldview may include or exclude weapons research. Likewise, an engineer's personal ethical values, which may augment professional ethical codes, might motivate him or her to prioritize a certain kind of research, such as research targeted to benefit resource-poor communities in the majority world – even if such work is decidedly less lucrative than many other engineering opportunities and involves increased personal risks from tropical diseases and other dangers.

The following are one-paragraph summaries of the twelve chapters of *On Being a Scientist*. That book and its list of additional resources can be consulted for greater detail (NAS 2009).

Advising and Mentoring. An advisor oversees a research project, whereas a mentor also takes a personal interest in a researcher's professional development. For instance, a mentor may suggest possible research directions and help with finding a job. Beginning researchers sometimes need several mentors to cover all of the areas of expertise they need, especially in multidisciplinary research. Good mentoring promotes the social cohesion that is so essential for the scientific community. To avoid possible confusion and disappointment, mentors and mentees should work out clear expectations together about availability, meeting times, and available equipment and funding. Although the mentee obviously benefits, the reverse also holds, that mentors benefit from exposure to new ideas and an extended network of collaborators. Mentoring is so essential to the functioning of the scientific community that it is advisable for scientific institutions to reward good mentoring and to offer training for established researchers in effective mentoring of beginning researchers.

The Treatment of Data. Because the data generated from observations of nature are the basis for scientists' conclusions, the data need to be collected and presented accurately, without drawing stronger conclusions than the data warrant. Otherwise, published errors can take on a life of their own, especially given rapid electronic communications, thereby making subsequent corrections less than entirely effective. Because scientific methods precede scientific data, methods must be described in sufficient detail to permit reviewers and readers to judge their adequacy and to replicate the research. Statistical analysis is an important tool for quantifying the accuracy of measurements and judging the significance of differences between treatments. Before publication, confidentiality may be appropriate to allow time for checking the data and conclusions. But after publication, other scientists should have access to the data so that they can verify and build on previous research. Some scientific specialties and journals have established repositories to maintain and distribute data. Technologies for digital storage are changing rapidly, so data may need to be transported to current platforms in a timely manner while this can still be done readily.

Mistakes and Negligence. Science is done by humans, who are prone to error. Even the most experienced and capable researchers can make mistakes. That is so especially at research frontiers, where available methods are being pushed to their limits, the signal is difficult to separate from the noise, and even the research questions are vague. As in life more generally, innovative scientists must take risks. But despite these understandable challenges and limitations, scientists have an obligation to their colleagues, themselves, and the public to be as careful and accurate as possible. Some errors are caused by negligence. Hasty or sloppy work, too little replication, and other faults can result in research that fails to exemplify the practices and standards of a given specialty. Often, the history of a specialty has already clarified the most frequent sorts of mistakes and the principal procedures and cross-checks that can minimize these mistakes, so researchers and reviewers should attend to this wisdom from past experience. Errors due to mistakes or negligence are often caught in the review process and thereby corrected in a timely manner. But the review process is selective and incomplete, so researchers cannot count on other persons to catch all of their mistakes and thereby keep those mistakes from further dissemination. Published mistakes can lead to other researchers wasting time and money and to the public receiving suboptimal medical treatments, defective products, and misleading ideas about nature.

Research Misconduct. Research behaviors at odds with the core principles of science are termed *research misconduct.* Such misconduct receives harsh treatment, jeopardizes the guilty party's career, and damages the overall reputation of science and thereby diminishes the potential benefits of science and technology for the public. The NAS (2009:15–18) description of research misconduct is based on a document from the US Office of Science and Technology Policy, which has been adopted by most agencies that fund scientific research. There are three kinds of misconduct. Fabrication is "making up data or results." Falsification is "manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record." Plagiarism is "the appropriation of another person's ideas, processes, results, or words without giving appropriate credit." In addition, the federal statement says that actions constituting misconduct must represent a "significant departure from accepted practices," must have been "committed intentionally, or knowingly, or recklessly," and must be "proven by a preponderance of evidence;" whereas it specifically excludes mere "differences of opinion." Beyond these federal guidelines, some research institutions and agencies have additional prohibitions against failure to maintain confidentiality in peer review, failure to allocate credit properly, failure to report misconduct or retaliation against those who do, and related matters. The crucial distinction between mere mistakes or negligence and serious misconduct is the intent to deceive, although a person's intentions are sometimes difficult to prove.

Responding to Suspected Violations of Professional Standards. Governments regulate some aspects of scientific research, but the scientific community is mostly self-regulating. For this to work, scientists must be willing to report suspected incidences of professional misconduct. Obviously, this is awkward, anonymity is not always possible, and reprisals from accused persons sometimes occur even though laws prohibit this. Allegations of misconduct can have serious consequences for everyone involved. Nevertheless, all scientists have an obligation to uphold the fundamental values of science, which includes reporting misconduct. All research institutions receiving federal funds must have policies and procedures to investigate potential acts of misconduct, including designating one or more officials, usually called research integrity officers. Because individual scientists and research institutions discourage inappropriate conduct, it is important to handle serious research misconduct and questionable research practices in different, appropriate manners. It is prudent to express suspicions initially in the form of questions, rather than accusations, because sometimes there is merely a misunderstanding. But such discussions do not always have a satisfactory outcome. In some cases, a preliminary and confidential conversation with a trusted friend or adviser may help, perhaps discussing only the broad outlines of the case without revealing specific details. In dealing with concerns about research misconduct, it is important to examine one's own motivations and biases, especially because inevitably others will do so. Institutional policies usually divide investigations of suspected misconduct into two stages: an initial inquiry to gather information, and a formal investigation to assess evidence and decide responses. These procedures are designed for fairness for the accused, protection for the accuser, and coordination with funding agencies.

Human Participants and Animal Subjects in Research. Research with human participants must comply with federal, state, and local regulations and codes of ethics of relevant professional societies. The intent is to minimize risks relative to expected benefits, obtain informed consent from participants or their authorized representatives, and maintain privacy and confidentiality. US federal regulations known as the Common Rule state requirements and require independent committees known as Institutional Review Boards. Research on animals is also subject to regulations and professional codes. The federal Animal Welfare Act requires humane care and treatment. Also, the US Public Health Service's *Policy on the Humane Care and Use of Laboratory Animals*, as well as the National Research Council's *Guide for the Care and Use of Laboratory Animals*, apply in many cases. Both the Animal Welfare Act and the *Policy on the Humane Care and Use of Laboratory Animals* require institutions to have Institutional Animal Care and Use Committees, which include experts in the care of animals and members of the public. The three main principles are the "three R's" of animal experiments: reduction in the number of animals used, refinement of procedures to minimize pain and distress, and replacement of conscious living higher animals with insentient materials when possible.

Laboratory Safety in Research. Government regulations and professional guidelines are intended to assure safety in research laboratories. It is estimated that in the United States, half a million workers handle hazardous biological materials every day. The short checklist presented in NAS (2009) includes appropriate usage of protective equipment and clothing, safe handling of materials in laboratories, safe operation of equipment, safe disposal of materials, safety management and accountability, hazard assessment processes, safe transportation of materials between laboratories, safe design of facilities, emergency responses, safety education of all personnel before entering the laboratory, and applicable government regulations.

Sharing of Research Results. Peer-reviewed scientific journals originated with the Royal Society of London under Henry Oldenburg's leadership. In current scientific practice, such journals provide the principal means for disseminating research results. Once published, those results can be used freely by others, but until they are so widely known and familiar as to become common knowledge, scientists who use others' results are obliged to credit their sources by means of citations. In addition, useful ideas from seminars, conference talks, and even casual conversations should be acknowledged. This allows readers to locate the original source of ideas and results and thereby to obtain additional information. Proper citation is essential, beginning with accurate author spellings, titles, years, and page numbers. Furthermore, citations should actually support the particular points claimed in a paper and identify the most relevant of the original and derivative articles. Citations are important for judging the novelty and significance of a paper. Researchers should be cautious about making results public before peer review because of the risk of preliminary findings containing errors. Also, some journals consider disclosing research on a website to constitute prior publication, which disqualifies it from subsequent publication in the journal. Scientists may be tempted to get as many little articles out of their research as possible in what are disparagingly called "least publishable units" in hopes of increasing their status or promotion prospects. But that can be counterproductive, producing a reputation for insignificant or shoddy work. The purpose of publication is principally to serve the interests of the scientific community, and beyond that the public, rather than being self-serving. To put the emphasis on quality rather than quantity, some institutions and granting agencies limit the number of papers that will be considered when evaluating a scientist for employment, promotion, or funding.

Authorship and the Allocation of Credit. The list of authors of a paper indicates who has done the work. Proper credit is important because the peer recognition generated by authorship affects scientists' careers. Establishing intended authorship early in the research process can reduce later difficulties, although some decisions may not be possible at the outset. There is a prevalent tradition that established researchers be generous in giving credit to beginning researchers. Whereas authors should have made direct and substantial contributions to the design and conduct of the research or the writing of the paper, lesser contributions can be credited by means of an acknowledgment – contributions such as providing laboratory space or useful samples, as well as helpful suggestions on drafts of the paper from colleagues and anonymous reviewers. The list of authors establishes not only credit but also accountability. Authors bear responsibility for any errors that may be found. In the case of multidisciplinary research, an author providing one kind of expertise may feel and, indeed, be incompetent to check the soundness of contributions from some other co-authors. But that can be handled by a footnote accompanying the list of authors that apportions credit and responsibility for the various components of the paper.

Intellectual Property. Scientific discoveries can have great value, for scientists in advancing knowledge, for governments in setting public policy, and for industry in developing new and better products. Intellectual property is a legal right to control the use of an idea by a patent or the expression of an idea by a copyright. These legal mechanisms attempt to balance private gains and public benefits. They give researchers, nonprofit organizations, and companies the right to profit from an idea in exchange for the property owner making the new idea public, which enables others to pursue further advances. US patent law specifies clear criteria defining who is an inventor, and it is important to include all persons who contributed substantially to an invention. Copyrights protect the expression and presentation of ideas, such as words and images in a publication; whereas they do not protect the ideas themselves, which others may use with proper attribution. Industry has the option of relying on trade secrets instead of patents. In that case, there is no obligation to make the idea public, but neither is there any protection from the idea being developed independently elsewhere. Most universities and research institutes have policies on intellectual property regarding data collection and storage, how and when results can be published, how intellectual property rights can be transferred, how patentable inventions should be disclosed, and how royalties are to be allocated among researchers and institutions. NAS (2010) provides additional information on intellectual property.

Competing Interests, Commitments, and Values. A conflict of interest is a clash among a scientist's personal, intellectual, and financial interests and his or her professional judgment. For instance, a professor who wants to commercialize some invention may be tempted to assign projects to his or her students that would expedite this commercialization, even if the students' academic interests would be served better by other projects. Researchers are usually entitled to benefit financially from their work, such as by receiving royalties or bonuses. But the prospect of financial gain should not prompt substandard experiments, biased conclusions, or exaggerated claims. Personal relationships may also cause conflicts of interest; accordingly, many funding agencies require scientists to identify others who have been their supervisors, graduate students, or postdoctoral fellows. A conflict of commitment, as distinguished from a conflict of interest, pertains to dividing time between research and other responsibilities, respecting an employers' mission and values, and representing science to the public. For instance, universities often limit the amount of time that faculty can spend on outside activities. A conflict of values can emerge from the values and beliefs that a scientist holds, including strong philosophical, religious, cultural, or political beliefs. However, as NAS (2009:46) insists, "it is clear that all values cannot – and should not – be separated from science. The desire to do good work is a human value." However, any values that compromise objectivity or introduce bias must be recognized and minimized.

The Researcher in Society. Scientists often provide expert opinion or advice to governments, universities, companies, and courts. They frequently educate the public about science policy issues and may also lobby their elected representatives or participate in political rallies or protests. When scientists become advocates on an issue, they may be perceived by their colleagues or the public as being biased. But scientists also have the right to express their convictions and to work for social change and justice, and that advocacy need not undercut a rigorous commitment to objectivity and truth. The main text of NAS (2009:48) concludes with a wonderful perspective on science's values: "The values on which science is based – including honesty, fairness, collegiality, and openness – serve as guides to action in everyday life as well as in research. These values have helped produce a scientific enterprise of unparalleled usefulness, productivity, and creativity. So long as these values are honored, science – and the society it serves – will prosper."

Finally, a prominent tool in teaching and learning professional ethics is discussion of provocative case studies, either fictitious or real. Besides the many case studies in NAS (2009), Resnik (1998:177–200) provided 50 more. Of course, in the spectrum between scientific misconduct and exemplary research, there is a nagging gray zone. To stimulate lively debate and thoughtful responses, these case studies tend to concentrate in this gray zone. But for the sake of brevity, this chapter leaves case studies to other readily available resources.

Discussion

Having listed a dozen unethical practices to avoid in the preceding section, this brief discussion turns to ethics' principal and positive objective, which is pursuing the good life. Some courses and books on science's ethics emphasize the negative, focusing largely on notorious and even criminal instances of misconduct. Such an approach to ethics fails to communicate that often the even greater challenges that we face involve encountering what is good and virtuous. This is what students need to be warned about most of all. Two little stories and one little joke may illuminate what is meant here.

The first story is about a young dog and its first bone. I was visiting a friend and his family one afternoon. Their family pet was a large dog about a year old that had never been given anything to eat except dry granulated dog food. That afternoon it was given its first bone, which had a little meat on it – the very food dogs are born to enjoy. But this bone was a greater treasure than this poor dog could handle. This dog became protective. It began snarling at my host's children if they got near. Nothing else had ever made this dog a threat to children, but encountering such a great good as this first bone did make this large dog dangerous. My friend had to intervene, alternately giving and taking the bone until finally his dog could respond better.

The second story is about Gimli and Galadriel, characters in J. R. R. Tolkien's *The Lord of the Rings*, from the chapter "Farewell to Lórien" in the first book of this trilogy. As fans of these stories will know, the dwarf Gimli has already suffered daunting perils and numerous battles by the time he meets the beautiful elf queen in Lórien, Lady Galadriel. Gimli wept as they departed Lórien and parted from Lady Galadriel, saying to his elf companion Legolas, "I have looked the last upon that which was fairest." Gimli continued: "Tell me, Legolas, why did I come on this Quest? Little did I know where the chief peril lay! Truly Elrond spoke, saying that we could not foresee what we might meet upon our road. Torment in the dark was the danger that I feared, and it did not hold me back. But I would not have come, had I known the danger of light and joy. Now I have taken my worst wound in this parting." In this story, "light and joy" are greater perils than "torment in the dark!" Is this a valid perception of human experience – of what tests us most deeply? That question is worth pondering.

Third and finally, a little joke goes like this. What is the worst party on earth? The answer is: the *great* party that you were not invited to. Note that the answer is not something like: a party with boring people, dreadful music, health-food snacks, and no beer. Implicit in this revealing joke is the wise perception that a great good missed is a worse pain than a substantial evil encountered.

Ethics is about misconduct. But first and foremost, an ethical vision defines the good life. The admirable code of ethics of the IEEE strikes this balance. It does reject dishonesty, bribery, discrimination, and such. But, more so, it emphasizes the great opportunities of scientists and technologists to promote the safety, health, and welfare of the public, to assist and support one's colleagues, and to discover and invent with skill in community.

For young students and professionals in science and technology, their greatest perils, and their greatest risks of regret in their old age, are not that they will fabricate data or steal ideas. Rather, their more likely perils are that simple laziness will diminish their contributions to society and colleagues, disabling complacency will prevent their mastery of scientific method, and reprehensible self-absorption will preclude their full appreciation of the wonder and beauty of nature.

Study questions

(1) The general public, as well as the scientific community, has a great diversity of worldview beliefs and commitments. What challenges or limitations does that diversity impose on philosophical ethics? Is there such a thing as a genuinely neutral, impartial, and universal reason for grounding ethics? Explain your answer.
(2) How does science depend on ethics and contribute to ethics?
(3) What are the three obligations of scientists identified in the professional ethics from the National Academy of Sciences? Give an example of each and explain why it is important.
(4) What are the three kinds of research misconduct? Give an example of each, fictitious or real. How does research conduct differ from questionable research practices? Give an example or two of questionable practices.
(5) Consider the IEEE code of ethics for engineers. Is there anything you would want to delete? Is there anything you would want to add? Give your reasons for each suggested change.