1 Introduction and overview

This book differs from many other introductions in philosophy, and even more so from those in science. It does not so much summarize existing knowledge – although it does some of that – as attempt to open a space for critical reflection on a spectrum of questions that were rarely asked until the late twentieth century. Philosophy and ethics deal with perennial questions, but here they are associated with new issues that nevertheless promise to become perennial in a world increasingly dependent on science and technology. By means of case references and interpretative arguments, the chapters that follow invite philosophical attention to the relationship between ethics and science, on the part of students and practitioners in the fields of both philosophy and science. The introductory chapter provides a quick intellectual geography of the terrain to be explored.

Setting the stage: the Manhattan Project

On August 2, 1939, Nobel Prize physicist Albert Einstein signed a letter (written by the Austro-Hungarian physicist Leó Szilárd) addressed to US President Franklin D. Roosevelt. The world's preeminent scientist felt a moral responsibility to inform the president of recent developments in nuclear physics. Scientific advances had raised the possibility of creating nuclear chain reactions that could unleash vast amounts of energy. This new knowledge might lead to the construction of bombs more powerful than any previously imagined, and Einstein concluded that Nazi Germany might already be pursuing such weapons. Roosevelt responded with an initial allocation of US$6,000 for preliminary research. This was the beginning of what became the "Manhattan Project," a massive, secret effort by the United States to build the atomic bomb. The project eventually employed 160,000 people working at centers in remote locations including Hanford, Washington; Knoxville, Tennessee; and Los Alamos, New Mexico. The push to build "the gadget" (as the scientist-engineers called it) was the most expensive research and development (R&D) project to that point in history.

Scientists and engineers overcame enormous challenges, and the first nuclear weapon exploded on July 16, 1945, over the desert sands near Alamogordo, New Mexico. Scarcely three weeks later, on August 6, 1945, the US *Enola Gay* bomber dropped "Little Boy" (a 90-kilogram uranium-239 device) on Hiroshima, Japan. Three days later another bomber dropped "Fat Man" (a plutonium bomb) on Nagasaki. Both cities had previously been spared attack and kept as "virgin targets" in order to test the devastating effects of the new weapons. The bombs leveled each city in turn, vaporized entire structures and human beings, burned thousands of people, and sowed radiation poisoning in flesh, water, and soil. Japan surrendered less than a week after the initial bombing. But radiation effects continued into the twenty-first century.

Upon viewing the test explosion the month before in New Mexico, J. Robert Oppenheimer, scientific director of the Manhattan project, quoted to himself, from the *Bhagavad Gita*, words spoken by the Hindu god Vishnu, "I am become death, destroyer of worlds."[1] He would later argue that as a result of their role in developing the atomic bomb, physicists had "known sin" and had a responsibility to educate the public about nuclear science. Indeed, many scientists associated with the Manhattan Project were appalled by the use of the bomb and wrestled morally with their degree of responsibility. Some created organizations such as the Emergency Committee of Atomic Scientists to lobby against the proliferation of nuclear weapons and to educate the public about the associated dangers. According to Einstein, "the unleashed power of the atom has changed everything," requiring a "new type of thinking" by humans. "We scientists who released this immense power have," he thought, "an overwhelming responsibility in this world life-and-death struggle to harness the atom for the benefit of mankind and not for humanity's destruction."[2] He also confessed that had he "known that the Germans would not succeed in producing an atomic bomb, [he] would never have lifted

[1] Rhodes 1986, p. 676. [2] Einstein 1968, p. 376.

a finger" to call the potential of the bomb to the attention of President Roosevelt.[3]

Other scientists and engineers continued to work on nuclear weapons, arguing that the weapons rendered their use too horrific to contemplate, thereby actually saving lives. Edward Teller, the "father of the hydrogen bomb," was especially vocal in defending nuclear weapons as a necessary deterrent to the Soviet Union, a totalitarian Communist state that after World War II had subjugated his home country of Hungary and threatened to invade the rest of Europe. Teller even went further, envisioning nuclear explosives as a means for pursuing such geoengineering projects as harbors in Alaska and a new canal between the Caribbean and Pacific. In the late 1950s, one of his scientific colleagues, Samuel Cohen, sought to turn the hydrogen bomb into a more clearly moral device by redesigning it as a "neutron bomb" that would kill people while minimizing destruction to buildings and physical property. As Cohen is quoted 50 years later in his obituary, the neutron bomb is "the only nuclear weapon in history that makes sense in waging war. When the war is over, the world is still intact."[4]

Soviet Premier Nikita Khrushchev, however, criticized the neutron bomb as one designed to "kill a man in such a way that his suit will not be stained with blood, in order to appropriate the suit."[5] US President Ronald Reagan, by contrast, accepted Cohen's argument and ordered production of 700 neutron weapons, although they were never deployed. Additionally, on the advice of Teller and others, Reagan established the Strategic Defense Initiative in the belief that technology could become a shield against ballistic missiles and protect the United States from nuclear attack.

By 1949, the Soviet Union had tested its first nuclear weapon and the world was locked in the Cold War. Recognizing how modern science and technology had come profoundly to influence global affairs and daily life, US President Dwight D. Eisenhower commented in his 1953 Inaugural Address:

> Man's power to achieve good or to inflict evil surpasses the brightest hopes and the sharpest fears of all ages. We can turn rivers in their courses, level mountains to the plains. Oceans and land and sky are avenues for our colossal commerce. Disease diminishes and life lengthens.

[3] "The Man Who Started It All," *Newsweek* (cover story), March 10, 1947. Cited in Isaacson 2007, p. 485.

[4] McFadden 2010, p. A35. [5] Shapiro 2010, n.p.

> Yet the promise of this life is imperiled by the very genius that has made it possible. Nations amass wealth. Labor sweats to create, and turns out devices to level not only mountains but also cities. Science seems ready to confer upon us, as its final gift, the power to erase human life from this planet.[6]

Beyond the issue of nuclear weapons, since the mid-twentieth century science has continued to expand the power of human beings to create and to destroy. On every continent, in the oceans, and even in outer space people now possess abilities to control and alter nature and human beings themselves to an extent unprecedented in history, through both intended and unintended consequences of advances in physics, chemistry, and biology. Such powers and the challenges they present make it incumbent on scientists and all citizens of contemporary society to bring ethics to bear in and on science.

Relations between ethics and science

It is common to think of science as objective and value neutral. If this is true, then ethics – as the systematic study of norms and values in human conduct – would seem to have only an external relationship to science. But the value neutrality of science is a myth that critical reflection readily challenges. Even as we assert the value neutrality of science, we often claim that science is a morally admirable enterprise that frees from superstition, discloses reality, speaks truth to power, and opens new pathways to material progress. Investments in science are justified by the goods science is alleged to bring, including not just knowledge but increased health and wealth, along with serving as a basis for better personal and public decision-making. Indeed, scientific knowledge is linked to moral imperatives for action. Once we know from science that smoking is harmful, is it not the case that there is an obligation to do something about personal behavior and public policy with regard to smoking?

Scientific knowledge is also often seen as an intrinsic good, valuable in its own right and as an expression of the human spirit of wonder

[6] "First Inaugural Address: Tuesday, January 20, 1953," Inaugural Addresses of the Presidents of the United States, Bartleby.com, 1989, www.bartleby.com/124/pres54.html.

and curiosity. Some see the practice of scientific inquiry as an activity that depends on and cultivates intellectual and moral virtues such as honesty, integrity, trust, fairness, perseverance, sound judgment, and open-mindedness. Ethical standards of right conduct are intrinsic to science (e.g., one must not fabricate or falsify data), making the canons of epistemological objectivity themselves constituents of an ethical ideal.

How can science be at once neutral and good? Perhaps it is good in one sense, precisely because it is neutral in another.

But why is it important for students of both philosophy and science to think critically about the relationships between ethics and science? In the first instance, this is simply because we live in a world that is increasingly distinguished by the presence and influence of science. To emphasize this point, consider seven often overlapping trends in science that invite ethical concern.

First trend: the increasing power of science

The first trend is the growing scale and power of science symbolized by the fiery, boiling mushroom clouds of atmospheric nuclear explosions. Indeed, we began with the Manhattan Project because this episode serves as a nodal point in cultural awakening to the profound ability of science to extend human power. Prior to the mid-twentieth century, science progressed with mostly celebration of its expanding powers because of the assumption that the new powers were always under the control of and proportionate to human understanding, which could be expected to use them wisely. By the end of World War II, however, suspicions began to arise that the powers of science might actually go beyond human abilities always to appreciate and manage them. It is one thing to understand and be concerned about the effects of science on a few people in the present. It is something else to understand and appreciate how new scientific powers might affect the planet or people thousands of years in the future. This suspicion about the powers of science becoming disproportionate to human capacities has only increased as science has (at the macro level) begun to consider geoengineering of the planet Earth and (at the micro level) to manage biological conception, reconfigure DNA, create hybrid organisms, and undertake the nano-scale designing of new materials. Can science so practiced continue to be thought of as proportionate to human understanding and control?

Second trend: threats and risks from science

Second, and connected with the growing power of science, has been an increasing awareness of its potential to generate knowledge with harmful implications and unintended consequences. Of course, tales about dangerous knowledge are as old as the stories of Prometheus and Adam and Eve. But by the last third of the twentieth century, the idea of dual-use knowledge of promise and risk began to pose real questions for the governance of science. As one dramatic example, nuclear science and engineering seem inextricably to enfold the potential benefits of nuclear electric power generation with the fearful risks of nuclear weapons, warfare, and accidents. In another example, in the 1960s Rachel Carson and other conscientious scientists deflated the utopian promises of "better living through chemistry" by connecting synthetic pesticides to biodiversity destruction, human illness, and environmental degradation.

In 1975, an international group of molecular biologists held a special conference at Asilomar, California, to draft new protocols for further work in the rapidly advancing field of recombinant DNA. The first instance of splicing genes into organisms raised not only hopes about improved drugs and crops, but also concerns about biohazards from biological weapons or super-organisms that escape control. Preceding the conference, in an unprecedented call for self-restraint, prominent scientists led by Paul Berg called for a temporary moratorium on such research. This trend has continued with concerns about R&D across a number of scientific fields, from information and computer science (enhanced communication linked with threats to privacy and cyberterrorism) and genetically modified foods (superfoods that undermine family farms or pose risks to health) to nanoscience and synthetic biology (new materials linked to threats of new toxins or even out-of-control self-replicating nano-bots). Can the potential goods of science ever be pursued without potential risks of harm? If not, how are risks to be controlled or managed and who should make such decisions?

Third trend: humans and animals as research subjects

A third trend fueling reflection on the ethical dimensions of science also had its origins in World War II. This pertains to the treatment of human subjects in research. Dr. Josef Mengele and other Nazi research physicians in Germany along with Japanese scientists in the infamous Unit 731 performed atrocious experiments on concentration camp inmates and prisoners of war, which included vivisection, research on the effects of hypoxia, nerve gas, freezing, high pressure, the ingestion of sea water, and more.

The immoral treatment of human subjects was not, however, confined to the Hitler and Tojo regimes. In the United States, biomedical researchers working in Tuskegee, Alabama, refrained for forty years (1932–72) from treating poor African-American men for syphilis in order to observe the long-term effects of the disease. Not until 1997 did President Bill Clinton make a formal apology for such treatment. Then in 2010 it was revealed that related US-sponsored human experiments had also been carried out on prisoners in Guatemala in the late 1940s.

Since the conclusion of the Doctors' Trial in Nuremberg in1947, numerous national and international bodies have drafted laws and guidelines to require the free and informed consent of human subjects of research. Indeed, in some cases the term "human participants" replaces that of "human subjects." Yet the interpretation and enforcement of these rules continue to pose ethical dilemmas, especially across cultural contexts. Additionally, since the mid-nineteenth century in England the use of nonhuman animals in scientific experimentation has sparked controversy about whether the benefits are sufficient to justify the animal suffering. The ability to replace some animal models with computer program models has only intensified this issue.

Fourth trend: scientific misconduct

A fourth trend is the continuing occurrence of scientific fraud and misconduct and questions about research integrity. This issue attracted prime-time publicity in the United States during the 1980s through several high-profile cases of misconduct, including fraudulent research on the treatment of mental retardation (by Stephen Breuning, University of Pittsburgh), disputes over credit for discovery of the AIDS virus (Luc Montagnier, Institute Pasteur, Paris, versus Robert Gallo, National Institutes of Health, Washington, DC), and allegations regarding data fabrication in the laboratory of Nobel Prize molecular biologist David Baltimore (of MIT and Rockefeller University). Government investigation of the third case, which was eventually judged not to be the fraud alleged, raised serious due-process issues of its own. Though numerous studies claim that the frequency of misconduct is low compared with other professions, instances of fabrication, falsification, and plagiarism (FFP) in science continue to grab headlines. They also pose difficult questions about how to define good science or the responsible conduct of research, adjudicate allegations of misconduct, treat whistle-blowers, and reduce instances of dishonest practices. Research misconduct threatens the integrity of science, undermining the trust essential to its operation and social value.

Fifth trend: commercializing science

A fifth trend is the increasing interdependence of science with business and industry. There is great potential here for good, as the resources and creativity of the private sector can foster beneficial research. But there are also dark sides to the "academic-industrial complex." Scientific values of free inquiry and open sharing can clash with corporate interests in protecting intellectual property for competitive advantage. Researchers working for private corporations often face scenarios where financial interests conflict with professional obligations. As public funding declines relative to private investments in many countries, questions arise as to whether nonmarket and common interest goods are adequately served by privately funded research. This can be especially problematic in developing countries, where opportunities for commercialization are often limited. Pharmaceutical companies naturally tend to invest in research on diseases that afflict the wealthy, who will be able to afford the resulting drugs. But this leaves underfunded research on malaria and other diseases that primarily afflict the poor. Moreover, when commercialization does occur in developing contexts it may unfairly exploit local people and resources.

Sixth trend: science in cultural and political controversies

Sixth, scientific methods, theories, and research often clash with other sets of ideas and values in multicultural societies. Historically, those who criticized some scientific claims – such as Christians who challenged heliocentric astronomy or biological evolution – did so in defense of traditional cultural beliefs that they saw as undermined by science, often claiming that science was overstepping its proper bounds. This argument has regularly been deployed to oppose an alleged tendency of scientific reductionism to weaken moral commitments. Indeed, the clash of civilizations that historian Samuel Huntington has used to characterize international affairs in the post-Cold War era could also be described as a clash between scientific and nonscientific cultures. Controversies surrounding embryonic stem cell research and prospects for human cloning, genetically modified organisms, the teaching of evolution in public schools, and global climate change are but the more prominent examples.

This trend can be broadened to include the entanglement of science and scientists in ethical and political controversies. Scientific advances often create "policy vacuums," or situations that demand choices. But the right path is seldom clear. For example, who should be allowed access to the information contained in an individual's genes? To what extent should the benefits of science be shared with "passive contributors" such as tissue donors or indigenous peoples whose practical knowledge is used in pharmaceutical development? Furthermore, public policy debates on everything from vaccinations to endangered species often pivot on claims about "what the science says." Determining precisely what science says can itself become a moral or political act of choosing which authorities to believe and how scientists convey levels of certainty and agreement to decision-makers or the public. Related questions surround the use of humanistic as well as traditional or indigenous forms of knowledge for public policy. On occasion, might certain ways of knowing other than scientific be appropriate guides for environmental, health, and other policies?

Seventh trend: science and technology

Finally, the atomic bomb aptly symbolizes a seventh trend, the increasing interdependence of science, engineering, and technology. Engineering and technology may in some sense be described as applied science; but science is also both applied and theoretical technology. Indeed, some claim the two realms are now so tightly coupled as to constitute a compound "technoscience" enrolled in socioeconomic innovation. Likewise, the distinction between nature (as studied by science) and material culture (constructed by technology, then studied by science) is increasingly replaced by the hybrid "nature–culture" (simultaneously studied and constructed).

Questions about ethics within scientific practice easily shade into questions about the ethical implications of the resulting products, both cognitive and material. This poses difficulties in thinking about the extent of their responsibilities for both scientists and engineers, with the two becoming increasingly difficult to disaggregate. For example, Hans Bethe – who led the theoretical physics division of the Manhattan Project – originally argued that scientific research should proceed even when it might be used for immoral purposes. It is only at the point of application, he contended, that people should debate whether to proceed, but "pure science" should not be stopped. Later in life, however, Bethe concluded that scientist-engineers had an obligation to cease further research on weapons that had proliferated beyond what he had originally imagined possible. A critical observer might wonder whether there is any bright line or easily controlled valve between research and application; science and application have perhaps become science–application and application–science. If so, how far do scientists' responsibilities extend?

Responses: professional, industrial, governmental

Uniting these trends is a common theme: science is such an integral and important part of society that it can no longer be – if ever it were – a refuge from ethical issues, challenges, and ambiguities. Reactions to this state of affairs have taken multiple forms. Across all disciplines, scientific institutions and societies have held conferences, produced publications, and drafted codes of conduct to bolster their capacities for self-governance. (For a selection of websites with ethics codes see the Appendix.) As one explicit manifestation of the relationship between science and ethics, we will often reference various codes of conduct throughout the book, beginning with the famous Nuremberg Code for the protection of human subjects in research.

The Nuremberg Code was imposed on science from outside. Other responses have come from within. In the mid-1970s, for instance, an American Association for the Advancement of Science (AAAS) Committee on Scientific Freedom and Responsibility recommended establishing a permanent committee of the same name to study "the general conditions required for scientific freedom and responsibility" and to respond to "specific instances in which scientific freedom is alleged to have been