THE INTERACTION OF ETHICS AND TECHNOLOGY IN HISTORICAL PERSPECTIVE

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With only minor stretching, ethics may be conceived as a technology-like science. Ethics is technical insofar as it involves specialized terminology and includes techniques for the making of human action; it is scientific in the sense of involving systematic reflection and critical analysis. Furthermore, as Caroline Whitbeck [1998] argues, there are strong parallels between problems in ethics and problems in engineering design. Thus independent of other considerations, it is appropriate that a handbook on the philosophy of technology and the engineering sciences should include a chapter on ethics and technology.

There are other reasons as well. In the European tradition, ethics — or systematic philosophical reflection on human action and its norms — can be traced back to Socrates, and from its earliest manifestations has included multiple references to technics or the arts and crafts, in the straightforward senses of the skilled making and using artifacts. Since the Renaissance such making and using has become increasingly systematized as technology and engineering, about which there have arisen further and more extensive ethical discourses. Ethics in such contexts has been called out to discuss technology as manifested in everything from objects and activities and their combined expressions in material culture to forms of knowledge and intentions. In these different aspects, technology has also been given moral shape by professional ethics codes, consumer use behaviors, and political determinations. Technology has thus influenced the way humans conceive and evaluate their worlds and itself been influenced by such evaluations. There exist extended interactions between ethics and technology that have contributed to shifts in ethical understanding and in technological making, using, thinking, and willing.

Given the breadth of such discussions, the present chapter will focus on the broad phenomenon of technology, while on occasion and as appropriate distinguishing notions of technique, technics, art, craft, invention, engineering, engineering science, and technoscience. (For more on these distinctions, see the chapter by Mitcham and Schatzberg in Part I of this Volume, "Defining Technology and the Engineering Sciences".) Indeed, within the general field of reflective engagement marked out by the phrase "philosophy of technology," ethical judgment has received more attention, especially insofar as popular discussions are concerned, than those from other branches of philosophy such as metaphysics, epistemology,

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and aesthetics. Almost any theoretical assessment of technology is likely to elicit a question concerning practical implications, and it is the resulting ethics and technology engagements that are surveyed here.

Following two sections that sketch a historical background, the chapter focuses on distinctly modern interactions between ethics and technology. The modern focus begins in section three by defining and illustrating three general schools of ethical reflection on technology found in European and American philosophy. Section four considers ways in which moral practice, informed variously by the schools of ethics and their approaches, shapes technology, working across professional, personal, and political levels. Section five considers briefly how technology can shape moral beliefs and practices by suggesting an interactive conception of technology and moral change.

1 PRE-MODERN ETHICS AND TECHNICS

Plants and animals alter the world by selectively ingesting materials from the environment, transforming them, and excreting newly formed materials. For a few animals, however, their own existence depends crucially on altering the world in more determinate ways. Spiders spin webs; birds build nests; beavers construct dams; and chimpanzees fashion tools. For no animal, however, is the making and using of physical objects more crucial to their lives and livelihood than for human beings, who make and use clothing, shelter, utensils, tools, utilities, weapons, structures, cities, transport and communication systems, and more, all as part of their distinctive way of being in the world — a way of being that differentiates into multiple traditions of material culture. In their technologically advanced forms, human material cultures have become comparable to geological forces in their abilities to alter the environment.

An early recognition of the defining feature of human making and using was classically expressed in the second chorus of Sophocles' *Antigone*:

> Of many wonders, none is
> more wondrous than human beings.
> They cross the seas
> with the winds storming and swelling
> and roaring about them.
> . . .
> Cunning are humans. Through mechanical contrivances
> they master the beasts of the field
> and those that roam the hills.
> The horse with the shaggy mane
> they hold and harness about the neck,
> and the strong bull of the mountains.
> And speech and wind-swift thought
> and the temperaments that go with political life

> they have taught themselves, and how to avoid
> cold frost under the open sky,
> and the pulsating rain as well.
> . . .
> Clever beyond all dreams
> are the mechanisms and *technai* of humans
> which bring forth at one time evil and at another good.
> When they honor the law
> and pursue the justice of the gods
> their cities stand, but dishonored are those whose reckless hearts
> make them join hands with evil.
> May we not think like them
> nor may such impious persons
> dwell in our house. (lines 332-375)

What is special about humans is that they navigate oceans, harness animals, and even tame their own impulses so as to be able to live together and build houses to protect against the elements. Yet to the Greek mind technical skills remained subordinate to a moral order, with those who acted outside the lawful framework being justly excluded from the human community. From the beginning of this appreciation of technical skill and its achievements, *techne* was thus associated with the possibilities of human good and evil. Already in the *Odyssey* technique or craft was identified with praiseworthy skill (e.g., *Odyssey* V, 259) and blameworthy trickery (e.g., *Odyssey* IV, 455). Likewise in the Hebrew scriptures, technical mastery and technics appear, on the one hand, as necessity and perfection and, on the other, as temptation or corruption. Noah built the ark in accordance with directions from Yahweh as a vehicle for salvation from the flood (Genesis 6:14 ff.), but subsequent humans used their technical prowess to construct the Tower of Babel as a spiritual rebellion (Genesis 11:1 ff.).

In the works of Plato (428-347) there emerged a more explicit ethical reflection on technics. In Socrates' autobiographies (*Apology* 15a ff. and *Phaedo* 96a ff.) it is not nature but the ideas of goodness, greatness, and beauty that were the orienting themes of philosophical inquiry. The search for a full account of ethical experience called forth an appreciation of different levels of being and different forms of knowing appropriate to each — though the highest reality was ethical, the good itself, conceived as "beyond being" *Republic* 509a-b).

According to Aristotle (384-322), however, philosophy originated when discourse about the gods was replaced with discourse about nature (compare, e.g., *Metaphysics* 983b29 and 988b27). In the Aristotelian tradition it is the study of nature, as cause of the distinguishing functional features of a species, that both constitutes natural science and provides insight into the *telos* or end of any instance of its kind. For Aristotle the various branches of philosophy themselves became distinguished, and ethics assumed the character of a systematic examination of *ethos*, as manifested in human customs or behavior. More than any other type of entity, humans have a nature that is open to and even requires further determinations through behaviors that actualize inherent potencies. At the individual level these supplemental determinations were called character; at the social level, cultures and political regimes. Their multiplicity provoked systematic (that is, in the classical sense, scientific) analysis and assessment.

Roman philosophers, carrying forward the Greek tradition, likewise examined the *mores* (Latin plural for *ethos*) of peoples, in what came to be called moral theory. Ethics and moral theory are but two terms for the same thing: systematic reflection on human conduct that seeks to understand the good for humans and thus serve as a basis for prudential guidance in human affairs. Although Cicero (106-43) did not explicitly include the arts, his assessment of the moral obligations associated with social "offices" is a formulation of role responsibility with general applicability. Role responsibility has served as a framework for understanding the moral obligations associated with the traditional forms of artisanship and the modern professions of medicine and engineering.

During the Middle Ages these articulations of moral theory (science) and practice (technique) were subsumed within a framework of divine revelation. According to Thomas Aquinas (1224-1274), for example, the supernatural perspective allows Christians to provide more perfect insights into the ultimate nature of reality and the human good than was possible for pagans. What for Aristotle could be no more than the counsels of practical wisdom became for Thomas natural laws of human conduct, laws that gear down the cosmic order and are manifest in human reason as a "natural inclination to [their] proper act and end" (*Summa theologiae* I-II, q.91, a.2). Additionally, influenced by the revelation of humans as created in the image of a creator God, Christians began to take special interest in technology. The century before Thomas witnessed the writing of the first book on tools (Theophilus Presbyter's *De diversibus artibus*), conceptualization of seven mechanical arts as complements to the seven liberal arts (in Hugh of St. Victor's *Didascalicon*), and an argument for technics as a way to remedy the loses of the Fall (another idea from Hugh). A contemporary of Thomas, Roger Bacon (1214-1294), even began to promote the development of a techno-experimental science and to imagine the possibility of such technical inventions as microscopes, telescopes, steam ships, and airplanes.

Despite the vast differences among such premodern thinkers, we can identify a fairly consistent view on the relations between ethics and technics. As Hans Jonas [1984] has argued, technics itself made no claim to high moral purpose. Unlike politics, virtue, or religion, for instance, technics was a quite limited aspect of human life — limited in power and effect. Both scripture and ancient political thought worked in a moral language of virtue, character, purpose, and discipline that instructed about proper human form and ends. They espoused a worldview where limits to the pursuit of technical intervention in self and world were crucial to self-perfection. The traditional forms of ethics thus tended to argue for restraint in the independent, progressive pursuit of science and technics.

Of course, technical skill was valorized when pursued within such limits and toward worthy goals such as the preservation of life and community. But the limits were all important, because technical activity can quickly be overextended and create wealth that undermines virtue, change that weakens social stability, and a will to power at odds with natural piety or human flourishing [see Mitcham 1994a, pp. 275ff.]. Moreover, in general, the premoderns judged artifacts to be less real than natural objects and technical knowledge as, correspondingly, on a lower level than other types of knowledge. Restatements of such premodern positions can be found in, for instance, the work of the neothomist Jacques Maritain (1882-1973), the Jewish scholar Leo Strauss (1899-1973), and the radical Catholic social critic Ivan Illich (1926-2002). Their message of limiting the pursuit of technics takes on a particularly contentious character when applied to medicine and agriculture.

2 MODERN ETHICS AND TECHNOLOGY

Beginning in the 1500s, the modern period witnessed an emerging transformation in the understanding of ethics, one related to a transformation in science and technology themselves. The scientific understanding of nature came to focus no longer on the natures of different kinds of entities, but on laws that transcend all particulars and kinds. The knowledge thus produced contributed to the transformation of technics into technology. This transformation denotes a change in scale from small handcrafts to large machines and industrial systems and a shift from animate to inanimate energy sources. This offered a new level of power to control or reorder matter and energy for external ends. These external ends increasingly came to be understood in terms of this-world human autonomy and welfare. Technological science thus became the basis for a progressive technological activity that produced artifacts more systematically and in greater abundance than ever before.

Thus, underlying the shift from technics to technology is also a fundamentally changed vision of the relationship between humanity and the order of things. This vision and its realization through technology were supported with ethical arguments by Niccolò Machiavelli (1469-1527), Francis Bacon (1561-1626), and René Descartes (1596-1650). Human beings deserve to manage and transform the world. This vision, going well beyond that of the chorus from *Antigone*, in which humans discover their place in nature through technical activity, is one of turning away from reflective observation toward a knowledge that enables humans not just to operate within but to control and subdue their environment. Moreover, no longer content to aspire with spiritual longing for recovery of a prelapsarian paradise, Machiavelli's new politics emphasized virtue as power while Descartes' new science aimed for humans to become "masters and possessors of nature" (*Discourse on Method*, Part 6). Where the ethics of technics had been one of properly proscribed limits, the ethics of technology was envisioned as infinite progress.

It was Bacon who most forcefully articulated the distinctively modern ethics of technology. In *The Great Instauration* (1620), on the basis of a moral vision of human beings as unjustly suffering in the state of nature — a vision supported by his creative deployment of Christian revelation — Bacon criticized Greek philosophy as a vanity of words and prayed for a new beginning in which natural philosophy would pursue knowledge linked to power. "I would address one general admonition to all," he wrote,

> that they consider what are the true ends of knowledge, and that they seek it not either for pleasure of the mind, or for contention, or for superiority to others, or for profit, or fame or [political] power, or any of these inferior things; but for the benefit and use of life.... I am labouring to lay the foundation, not of any sect or doctrine, but of human utility and power. ["Preface," paragraphs 5 and 6]

To this end his proposal for a new, methodical engagement of the mind with nature would be based in

> a history not only of nature free and at large (when she is left to her own course and does her work her own way), — such as that of the heavenly bodies, meteors, earth and sea, minerals, plants, animals, — but much more of nature under constraint and vexed; that is to say, when by art and the hand of man she is forced out of her natural state, and squeezed and moulded. Therefore I set down at length all experiments of the mechanical arts, of the operative part of the liberal arts, of the many crafts which have not yet grown into arts properly so called .... Nay (to say the plain truth) I do in fact (low and vulgar as men may think it) count more upon this part both for helps and safeguards than upon the other; seeing that the nature of things betrays itself more readily under the vexations of art than in its natural freedom. ["Plan of the Work," paragraph 21]

In his use of the term "art," of course, Bacon means to reference technics if not technology.

In further contrast to the ancients, for Bacon technical change is inherently beneficial because it enhances human welfare and autonomy. People suffer more from the elements than from other human beings; they should therefore work together to conquer nature through science and art. As historical proof for his position Bacon sites how the inventions of printing, gunpowder, and the compass have been of more benefit to humans than all previous political activity, philosophical debate, or theological argument [*Novum organum* I, 129]. In the following two centuries first the Enlightenment and then the Industrial Revolution flourished in conjunction with the progressive articulation of such ideas about how humans might, through a new linkage between science and technics, remake both the physical and human worlds to satisfy desires. The creation of modern economics as a theory that endorses the pursuit of individual material self-interests was arguably the single most influential promotion of this linkage.

Ethics also began to be re-systemized and moved from a reliance on prudential guidance toward the formulation of rules for human conduct. Divides emerged among different rule-focused ethical systems, but the major approaches nevertheless agreed in trying to formulate ethical decision making processes that could be practiced with competence and regularity on scales that would be able both to advance and to cope with the new powers of industrialization, technization, and globalization. The modern period thus witnessed the development of ethics as a science with a unique intensity and scope.

The theoretical development of a new science of ethics emerged in different but related forms within the empiricist and rationalist traditions of modern European philosophy. In the empiricist tradition, as exemplified in the work of David Hume (1711-1776), morality was argued to be based in human sentiment, which gave to ethics a subjectivist cast. Elaborating this perspective Jeremy Bentham (1748-1832), John Stuart Mill (1806-1873), and their followers developed a utilitarian theory that understood morality as rules for the pursuit of happiness by maximizing pleasures and minimizing pains. Pragmatist ethics replaced happiness by a wider conception of projected ends but continued to stress instrumental effectiveness in their pursuit. In the rationalist tradition, by contrast, Jean-Jacques Rousseau (1712-1778) and Immanuel Kant (1724-1804), grounded morals in a non-instrumental rationality of inner consistency. Kant and his followers developed a deontological or duty-focused ethics in which moral behavior was assessed in terms of intentions and their universalizability. This appeal to rationality ascribed to ethical principles a certain non-empirical but nonetheless objective character analogous to that found in mathematical laws.

Both traditions were at one, however, in struggling to deal with the ethical challenge created by the loss of nature as embodying a normative potency, an inner reaching for perfection, within and without human beings. Prior to the modern period, natural entities were understood as possessed of functional tendencies toward harmony with the orders of being. When they functioned well and thereby achieve such *teloi* (or fitting ends), then fire ascended, seeds grew into flowers and trees, animals matured and gave birth to offspring, human beings spoke with one another and made offerings to the gods. Furthermore, fire and trees and humans fit in with and were parts of greater natural orders. Since these harmonies or proportionalities are what constituted being itself, they were also good, which is simply the way that reality presented itself to and drew forth or perfected the appetite.

For the premoderns, moral practice was thus oriented toward the perfection of human nature. By contrast, insofar as nature came to be seen as composed not of entities with natures to be realized, but as indifferent matter able to be used one way or another and modified at will, questions arose about the foundations of the good as an end to be pursued and the rightness of any means to be employed in such pursuit. The romantic, rear-guard defense of nature as an aesthetic phenomenon only succeeded in modifying the modern trajectory at its margins. Instead, modern ethics initially manifested a basic shift, once teleology was replaced by balances of material forces, from efforts to identify the good as a natural end to goods as desires or ideals. Stated another way, the moderns replaced "the good" with "goods" or "values." The good in the premodern sense was understood as a standard, that of reality as an ordered whole transcending personal interests, that could serve as a guide for the assessment of such interests. Modern values took whatever was the object of personal interest or the interest-producing entity itself as the standard.

Efforts to make consequentialst and deontological systems truly scientific have been variously pursued. During the late nineteenth and early twentieth centuries pragmatism sought to integrate especially the empirical social sciences into assessments of what might be the most effective means to pursue ends of interest. In the first half of the twentieth century aspirations to more formal rigor led to the development of metaethics. Eschewing normative analysis, metaethics aspired to clarify the structure of ethical language and its distinctive logic. In its most radical form metaethics reduced the meaning of ethical statements to forms of emotional approval; in more moderate forms it simply disclosed the complexities of ethical judgments, sometimes seeking to rectify inconsistencies. During the middle of the century ethics took more operational form in the mathematics of game and decision theory, operations research, and risk-cost-benefit analysis.

In the last third of the twentieth century, however, the inadequacies of the social sciences, metaethics, and the formalization of decision theoretic procedures in the face of substantive issues presented especially by the creation and use of technology brought about the development of applied ethics. One formerly metaethical philosopher interpreted this intellectual turn as a transition that "saved the life of ethics" [Toulmin, 1982]. In effect, this also proved the occasion for a revitalization of pragmatist ethics (see, e.g., [Keulartz *et al.*, 2002]).

3 ETHICS REFLECTING ON TECHNOLOGY: THREE SCHOOLS

Beginning with the early twentieth century, ethics became increasingly engaged with technology across a wide range of issues. So extensive has been this engagement that any overview of ethics interactions with technology is compelled to adopt some kind of simplifying perspective in order to attempt an approximate coverage. For present purposes, developments will be described as taking place in three distinctive ethical contexts with consequentially different emphases. Two of the contexts had their roots and orientation in the rationalist European tradition and were manifested in what will be termed socio-critical and historico-cultural schools or approaches. The third was more empiricist in orientation and associated with what become known as the modern analytic practice of philosophy. But it is important to note that by the end of the century mergers from these three schools were the norm, so that the narrative here should be used primarily to stimulate appreciation of how different perspectives are coming to mutually influence one another especially in relation to technology.

As Table 1 indicates, the ethical problem space was originally defined somewhat distinctly for each of the three schools. Socio-critical approaches were generally concerned with reforming economic and political structures associated with technology in order to better accord with an ideal of human freedom; historico-cultural philosophy addressed questions of the meaning of life; and analytic work sought clarity in conceptualization and argument. In both the socio-critical and historico-

Table 1. Three Schools of Ethical Reflection on Technology

School	Socio-critical	Historico-cultural	Analytic
Frame	Technology as productive process with potential for human liberation	Technology as way of being and perceiving and threat to authenticity	Particular technologies in context as problems or solutions
Emphases	Historically informed orientation and social reform	Historically informed orientation and personal meaning	Isolated concepts and piecemeal problem solving
Roots	Rationalism, Marxism, pragmatism, and neoliberalism	Rationalism, phenomenology, and existentialism	Empiricism and utilitarianism

cultural schools, discussions of ethics and technology developed with reference to the kind of historical background sketched in sections one and two. In particular, both contended that modern technology uniquely transformed the human condition and that received moralities were inadequate to address the altered situation. Phenomena such as dehumanization or inauthenticity were seen as characteristic of the historical emergence of modern technology in general rather than associated with any particular kind of technology. Whether workers were engaged with steam engines, chemical processing plants, electronics, or nuclear power does not matter; in each case they were faced with existential antagonisms between their socio-political aspirations, lived experience, and material culture. Steam engines dwarfed human physical activities, chemical processes poisoned and polluted, electricity and magnetism escaped any immediate grasp by the human sensorium, nuclear power contained inconceivably destructive potential. But there were disagreements within and between these first two traditions about the particular ways in which technology has altered the human lifeworld and about the appropriate moral responses.

Analytic ethics, by contrast, worked with more isolated and well-bounded problems and tended to reject the notion of modern technology as a fundamentally new mode of human experience and social order. For analytic philosophers it was not history but problems that are controlling. Finally, the analytic tradition at least initially maintained a boundary between facts and values. It accepted the scientific knowledge of facts as a cognitive paradigm, with values understood as expressions of non-cognitive human sentiments or interests that come into conflict and as such need to be clarified and adjudicated. By contrast, Marxism saw both science and morality as expressions of class interests, while phenomenology viewed scientific knowledge as a restricted if not diminished form of cognition. Additionally, in the socio-critical and historico-cultural traditions facts and values were argued to both be phenomena and thus equally open to systematic analysis and criticism. Thus, neither of the first two schools poses any radical gap between facts and values. Attitudes toward an alleged fact/value distinction over the course of the century become much less a dividing line between the analytic and the other two schools but their approaches to the relationship between these two aspects of experience have remained modestly at odds. To explore such comparisons in greater detail, however, it is appropriate to proffer a more extended examination of these distinctive schools.

3.1 Socio-critical approaches

The most influential figure in the socio-critical school has been Karl Marx (1818-1883), whose "critique of political economy" aimed to undermine what he saw as naive beliefs in the political benefits of industrial technology and associated economic structures. According to Marx, "the modern science of technology" undermined traditional skills and the satisfactions of craft production, placing workers under the control of large-scale, capitalist-owned factories in which labor functions became equal and interchangeable [*Das Kapital* I, 13]. This disturbed a traditional social ecology in which the "species essence" of material production was once directed to the general human welfare, a corruption that could be corrected only by means of a social revolution in ownership of the new technologies. The Marxist ethical assessment of industrial technology thus highlighted technological change as restructuring society such that prior economic orders were made obsolete.

The focus of Marx's critique was not on the quality of the emerging consumer society, but the maldistribution in power over production. His position was opposed to the attempts of both "utopian socialists" and liberal economists to manage the creative destruction of technological change. On one hand, Henri de Saint-Simon (1760-1825) in France called for a "New Christianity" to manage society through a technocratic linkage of scientists, artists, and industrialists, while Robert Owen (1771-1858) in England established cooperative worker-owned industrial model communities such as New Lanark. On the other hand, classical liberal economists conceived of production in terms of inputs and outputs organized by what Adam Smith (1723-1790) described as the "invisible hand" of the free market. For Marx, technocratic management was not enough, because ordering the technological society required more than just technical knowledge, and idealistic model communities were unable to transform entrenched techno-political institutions. Similarly, though liberal economists recognized the primacy of production over politics, they failed to appreciate that productive processes were always also social processes.

Marx's effort to liberate techno-economic powers from bourgeois class interests rested with a new analysis of production. It examined "how the instruments of labor are converted from tools into machines" and the way machines themselves tended to become organized into a system in which "the subject of labor goes through a connected series of detailed processes" [*Das Kapital* I, pt. 4, Chapter 13, Section 1]. In an economy where capitalists owned the means of production, workers existed as wage slaves tied to specific mechanical routines. Only if the means of production were placed in worker hands would they be free in reality to "become accomplished in any branch [they wish]," to "do one thing today and another tomorrow" [*Die deutsche Ideologie* I, 1, a]. Only liberated from the capitalist mode of production would modern technology realize its ability to promote not only justice but also true human freedom.

The reality was that technology made wealth and freedom possible for everyone, but its historical appearance realized this ideal only for the few capitalist owners. Subsequent economic developments that reduced extreme depredations of poverty without bringing about worker liberation in other forms, gave rise to what has become known as the Frankfurt School of social theory in the work of Max Horkheimer (1895-1973), Theodor Adorno (1903-1969), and Herbert Marcuse (1898-1979). Their work and that of such leading students as Jürgen Habermas, William Leiss, and Andrew Feenberg shifted critique from a focus on political economy to a questioning of the character of the Enlightenment, attributing the failure to realize the full liberating potential of technology not simply to economics but to culture.

For Horkheimer and Adorno, the Enlightenment produced "instrumental reason" — without, however, providing a guideline in objective reason (theory) for how the new powers of reason were to be used. This led to the production of social orders dominated by the military and the "culture industry," that is, brute force and entertainment. Rather than leading to an ever-larger conversation about goals and values, Enlightenment reason was reduced to instrumental thinking concerned with increasing the efficiency of means in order to achieve already given ends. Their dystopian conclusions were similar to sociologist Max Weber (1864-1920), who described the process of rationalization, or the increasing role of calculation and control in industrial democracies, as creating an "iron cage" of bureaucracy that stifled individual freedom. Marcuse rejected this pessimism, arguing that although technology was oppressive under capitalism, it might be otherwise under a different social order such as that foreshadowed by the student counterculture of the 1960s or the women's liberation movement. In place of Marcuse's apotheosis of the counterculture, Habermas developed a theory of communicative action as a formal guide for political and technical development.

A number of other efforts that may be loosely associated with critical social theory focused directly on promoting the democratic participatory control of technology. Langdon Winner [1986] and Richard Sclove [1995], for instance, argue that technological artifacts even more than political institutions influence the way people lead their lives. Given the ethical principle that individuals should have a say over what affects them, technological decision making and design deserve to be subject to the same standards of public participation as political decision making. Such threats as computer invasions of privacy and technological transformations of the environment only reinforce the ethical principle of "No innovation without representation" [Goldman, 1992]. More positively, Feenberg [1995 and 2000] offers proposals for reconfiguring the diverse possibilities of technology. These include action by which workers would recontextualize their labor, public recognition of the human significance of vocation, investment of aesthetic and ecological value in technological products, and the pursuit of voluntary collegial cooperation in work.

In a complementary manner the institutional sociologist Thorstein Veblen (1857-1929) argued that engineering attitudes and technological achievements were being corrupted by pecuniary interests and the price system. Controlled by persons of limited perspective, the full potential of technology was being thwarted. Again, the full capabilities of technology for contributing to human welfare were not being realized. Such arguments all constitute attempts to re-enclose technology within a new social framework. Despite important variations, the main theme has remained: the liberating powers of technology can only be realized under the right social circumstances, which thus deserve careful and conscious restructuring.

A diametrically opposed ethical argument for liberation of the full potential inherent in technology can be found in neoliberal entrepreneural and libertarian economics that became prominent in the latter third of the twentieth century, drawing inspiration especially from the thought of Frederich Hayek (1899-1992). The neoliberal revival and defense of a classical liberal economic perspective on technology relied on Hayek's distinction between two fundamentally different types of human making. Material artifacts can be the result of conscious or intentional technological design. But such human constructions as language and the free market are "the result of human action but not of human design" and are not subject to direct intentional control [1967]. Indeed, for Hayek and others any attempt to control or manage technology in the name of equality will not only be counterproductive but may also require unethical restrictions on human freedom. Additionally, the libertarian political philosopher Robert Nozick [1974] considered the alleged general principle of "having a say over what affects you" and found it wanting. He defended as legitimate, innovation without representation, when the innovation is pursued in relation to one's own primary goods, even though it may have secondary effects on others.

Thus, classic liberal economic theory made an essentially moral argument for the liberation of science and technology from state control. Liberated from political control, industrial technology would enhance human freedom and welfare and, not incidentally, limit state power. Moderate versions of liberal economics, however, have recognized the need to complement liberty with order and equality, which often necessitates a modest amount of state intervention, although nothing as radical as a political revolution in the ownership of technological property.

Finally, the pragmatist John Dewey (1859-1952) developed a different argument for complementing liberty with equality in the exercise of technology. For Dewey, the black box of technology was opened not so much as a social production process as one of cognition and practice. Human beings, like all organisms, exist in an environment in which they are trying to achieve specific ends or what Dewey calls "ends in view." When frustrated in their efforts to achieve these ends, problematic situations arise that people have the potential to subject to conscious analysis and to inquire concerning possible responses — entertaining hypotheses about modifying the ends to be pursued or improving the means to be utilized. Human beings then test the alternatives and undertake new forms of behavior on the basis of what they learn. As it becomes increasingly conscious and effective, this process of inquiry and improvement in human thought and action is, for Dewey, what is meant by technology. As argued by Larry Hickman [1990], Dewey's notion of the free development of technology so construed should not be limited to industrial production but should be generalized and applied equally across the full range of human experience, from social and political affairs to art and religion.

3.2 Historico-cultural approaches

In the historico-cultural school of the assessment of technology, reflection was framed not in terms of technology as a productive process and its possibilities for human liberation, but in relation to science and technology as forms of consciousness. From this perspective, the primary danger has been argued to be some form of inauthenticity or bad faith — that is, failures on the part of individuals to recognize and accept the ways in which they are responsible for the lifeworld they create and their attitudes toward it.

The attacks on the inauthenticity of Christian culture by Søren Kierkegaard (1813-1855) and the iconoclastic pronouncements of Friedrich Nietzsche (1844-1900) founded what has been called the existentialist movement, which involved a special ethical stance toward technology. Although he did not thematize it as such, from the perspective of Kierkegaard modern technology could be interpreted as a form of bad faith. For Nietzsche, technology might be described as genealogically rooted in a slavish morality that valued convenience and safety over a life of heroic reach and challenge. Nietzsche's two-pronged attack on scientism and technological culture — scientism understood as the claim that science is the highest form of knowledge and technological culture as one in which massification and consumerism have conspired to corrupt nobility of achievement in art, music, and literature — exposed a nerve of doubt and resistance to the trajectory of technological progress. Science and technology threatened to trap humans in an impoverished existence that denied their deepest truths. As such Nietzsche has fertilized an ethical stance deeply at odds with that of Francis Bacon and his Enlightenment heirs, one at the root of a diversity of existential ethical engagements with technology.

It was Edmund Husserl (1859-1938) who turned genealogical analysis into a method that he named phenomenology. Husserl refused to accept science on its own terms and argued that science was not self-explanatory. His description of the genesis or coming to be of scientific phenomena disclosed that more fundamental than science was a lived experience or lifeworld from which modern science itself was abstracted with the aid of technologicial instruments. The technoscientific world was argued to be a reduced or diminished form of the lifeworld on which it remained, often unknowingly, dependent. Husserlian phenomenology was concerned with disclosing the ongoing framework — that pre-existing familiarity with the world — that made all human experience possible. As Maurice Merleau-Ponty noted, the return to the lifeworld or "the things themselves" was "from the beginning a disavowal of science" [Merleau-Ponty, 1945, p. ii]. Humans are not objects of biological, psychological, or sociological investigation. All knowledge, including scientific and technical knowledge, can be argued to be gained from a particular point of view or experience without which the symbols of science and engineering would be meaningless. Merleau-Ponty and others made more explicit Husserl's implicit ethical critique of the modern scientific worldview and the lifeworld transformed by modern technology.

Three other important contributors to development of the historico-cultural criticism of technology were Max Scheler (1874-1928), José Ortega y Gasset (1883-1955), and Martin Heidegger (1889-1976). According to Scheler, the historical transformation of the lifeworld was more than an economic or productive phenomenon; it was also the rise and dominance of a new "ethos of industrialism" even among technical workers themselves. Such an ethos (which is intermediary between moral principles and moral actions) exalted utility and instrumental values over vital and organic ones. This is a distortion not just of the economic order but of an axiological hierarchy — a distortion that calls for a cultural reformation.

For Ortega, however, right within modern technology and the ethos of industrialization there arose a moral problem that cannot be addressed by means of either social revolution or cultural reform. Scientific engineering, in contrast to traditional craft technics, radically increased what can be done without any corresponding deepening of ideals about what should be done. In Ortega's formulation of the issue: Previously human beings, struggling to achieve some vision of what it was to be human or a lifeworld, only acquired a particular technics in a form already embedded in an existing cultural project; as a result they only possessed a particular instance of what might be called technology in general. But with technology and the engineering sciences human beings possess technology in general disembedded from any particular cultural project. They are thus able to do almost anything prior to having any idea about what they really want to do. To address this problem, Ortega concluded his *Meditación de la técnica* [1939] by suggesting the need to cultivate what he called "technics of the soul." The suggestion is perhaps echoed in subsequent proposals by Günther Anders [1961] for a moral education capable of matching the power of our imagination (*vorsellen*) with the technological expanded power of our abilities (*herstellen*).

Heidegger was undoubtedly the most influential European philosopher to address the issue of ethics, science, and technology from the historico-cultural perspective, even though he rejected the discipline of ethics as such. In his "Die Frage nach der Technik" [1954] Heidegger undercut the distinction between science and technology, and argued that modern scientific technology — or what Bruno Latour [1987] would latter call technoscience — is not so much an ethos as a form of truth. This truth or knowledge reduces the world to *Bestand* or resources available for manipulation by a world-configuring, nihilistic destiny he calls *Gestell*. Heidegger seemed at once to make ethical reflection more necessary than ever before and to destroy its very possibility. Less controversial is his thesis that science and technology are interpenetrating practices: the science of nuclear physics is as much the applied technology of cyclotrons and reactors as the technology of nuclear engineering is applied nuclear physics. To the extent this is the case, the ethics of science tends to merge with the ethics of technology.

Two other thinkers who are not always identified as philosophers, but who have nevertheless contributed to the historico-cultural assessment of technology, were Lewis Mumford (1895-1990) and Jacques Ellul (1912-1994). As a social historian and cultural critic, Mumford argued that modern age technics (his term for technology) has transformed the making and using of artifacts into a complex sociotechnical system oriented almost exclusively toward power and control. This "mono-technics" was actually foreshadowed by premodern slave-labor "megamachines" for large-scale construction projects such as the Egyptian pyramids. In contrast, Mumford promoted the recovery of "bio-" or "polytechnics" oriented toward a living multiplicity of human interests and activities, from religious ritual to aesthetic creativity and play.

As a sociologist and theologian, Ellul distinguished technical operations from their distinctively modern unification in the technical phenomenon or *la Technique* (translatable as "technology") [Ellul 1954]. The distinctive feature of this phenomenon, in Ellul's view, is the effort to turn human activities toward the pursuit of some form of efficiency, that is, to assess all dimensions of culture in terms of an input-output analysis. As efficiency analysis comes to dominate in economics, in politics, and even in health care, education, and sports, technology takes on a semi-autonomous character that undermines human freedom. To counterbalance such technological determinism — that is, the making of decisions always with a concern for opportunity costs, risk-benefit analysis, or other forms of calculative rationality, the combination of which is in effect to enhance technological power — Ellul argued for an "ethics of non-power" that would encourage individuals voluntarily to delimit technicization, especially in their relationships with persons and with nature. One way to interpret Michel Foucault (1926-1984) and his controversial analyses of the disciplinization of modern life, from the insane asylum to biopolitics, is as providing a complementary perspective on other aspects of the same phenomenon with which Ellul was concerned.

Finally, Albert Borgmann [1984] offers another critique and response to the technology-culture relationship in terms of human meaning or the good life. For Borgmann, technology takes shape as a ruling pattern of human experience that he calls the "device paradigm." The conveniences of consumer culture offered by mass-produced devices are alluring but ultimately impoverished substitutes for engaging experiences with "focal things" or through "focal practices." Although only briefly summarized here, Borgmann perhaps more than any other cultural critic enters into extended dialogue with diverse approaches, from economics and social criticism to political theory as well as systematic defenders of existing technological trajectories, and then deftly restates with renewed vigor a full spectrum of major concerns about the cultural consequences of technology. In Borgmann, for instance, one can find echoes of Illich's concept of a "counter productivity" in technological progress that undermines friendship, community, health, and other experiences central of meaningful lives, but presented in the framework other than Illich's own slash-and-burn attack; for Borgmann it is always necessary to offer a positive vision that can motivate efforts to recapture missing aspects of a once vibrant lifeworld. In addition, one can find Borgmann himself echoed in worries by Leon Kass [2003] concerning consumer driven experiments in the pursuit of improved children, performance enhancement, ageless bodies, and psychological happiness.

The holistic approach characteristic of the historico-cultural school is nevertheless dependent on some attempt to address particular issues, if only to illustrate more comprehensive claims. Borgmann's contrast of the premodern focal hearth and the central heating system to illustrate the device paradigm is a case in point. Some theorists can be interpreted as heirs of the historico-cultural tradition, even when they rely more heavily on context-specific studies, an emphasis Hans Achterhuis [2001] labeled as the "empirical turn" in ethical reflection on technology. Practitioners often retain an interest in evaluating science and technology in terms of their broader human and cultural significance, but do so by relying on empirical case studies of specific artifacts and actual practices, which makes them open as well to analytic approaches (e.g., [Verbeek, 2005]).

Those adopting the empirical turn in the contextual examination of technological artifacts, ask both how specific artifacts mediate or shape experience and how user behavior shapes the function or meaning of artifacts. For instance, Donna Haraway [1985] uses detailed studies to support her theory of the "cyborg," a being whose lifeworld, self-interpretation, and social context are permeated by technology. By questioning normalized categories, she de-naturalizes (shows the contingency of what had seemed necessary) the power of those who define the categories, thus using cyborg theory to advance feminist, socialist, and anti-racist ethical ideals. Additionally, Diane Michelfelder [2000] argues that what is important for the lifeworld is the moral significance of material culture understood from the viewpoint of actual user experiences. A mass-produced box of wine may be a "device" for Borgmann, but if shared at a festive meal it may still function as a "focal thing."

3.3 Analytic approaches I: background

As they came to the fore during the mid-twentieth century, analytic engagements with technology tended to reflect two beliefs: that technology has not fundamentally altered the human condition and that received ethical theory is largely adequate — or, paradoxically, irrelevant — to address associated moral issues. While viewing technological development as continuous and progressive from stone tools to electronic computers, and by questioning any need for radically new moral theory, analytic approaches adopted a loose method focused on a dialogue between mid-level theory and concrete issues seeking to clarify divergent problems associated with diverse technologies. Indeed, a progressive orientation can also be detected in the genial confidence with which problems were approached as meliorable if not solvable.

Being the broadest of the three schools of ethical reflection, any attempt to survey analytic approaches is difficult. The only major individual who stands out as consistently engaged with technology was Bertrand Russell (1872-1970), who considered ethics a more public intellectual activity than one representative of professional philosophy. His contributions often tended toward political provocation, as in *Why I Am Not a Christian* [1927]. A life-long anti-authoritarianism and sympathy for the underprivileged led to both active protest against World War I (for which he served six months in jail) and a consistent skepticism about the social benefits of what he called scientific technique. *Icarus, or the Future of Science* [1924] was written in explicit criticism of the optimism found in J.B.S. Haldane's *Daedalus or Science and the Future* [1924]. Although Russell defended scientific knowledge as an ultimate truth about the world with manifest human benefits in the technologies of food and consumer goods production and health care, he also emphasized the manifold ways such knowledge could be abused when under the control of totalitarian governments or those deficient in a relevant education [Russell, 1951]. For Russell the only hope was better democratic education in science and technology [see, e.g., Russell, 1958]. Most dramatically, Russell strongly opposed the development, use, and spread of nuclear weapons; in 1955, after the U.S. testing of the hydrogen bomb, he drafted a manifesto co-signed by Albert Einstein that called on scientists and engineers to take more public responsibility for their work — and thus stimulated the 1957 creation of an on-going series of Conferences on Science and World Affairs that became known as the Pugwash Movement (after the name of first meeting place, Pugwash, Nova Scotia).

The question of technology and warfare was the leading edge of analytic ethical engagements with technology. Along with Russell, for instance, G.E.M. Anscombe (1919-2001) — a student of the other major figure of analytic philosophy, Ludwig Wittgenstein (1889-1951) — opposed British bombing policies in World War II (and in the 1960s endorsed the Catholic rejection of certain technological means of contraception). Other analysts brought their methods to bear on postwar nuclear deterrence policy, and from there analysis spread out across diverse categories of technological activity: chemical processing and manufacturing; biomedicine; information, communication, and media technologies; agricultural and biotechnologies; and nanotechnologies. (New categories on the horizon include emerging/converging technologies and synthetic biology.) Earl Winkler and Jerrold Coombs [1993] consolidate this diversity into three basic applied ethics domains — bioethics, business ethics, and environmental ethics — and argue that in each case problem generation was closely associated with advances in technology. Adding to these the neglected domain of computers and information technology yields four basic domains of applied (mostly analytic) ethical reflection on technology.

As Winkler and Coombs additionally suggest, the analytic ethics of technology can be situated as part of a shift within philosophy itself from metaethics to applied ethics. One pivotal contribution to this transformation was work by Toulmin. For Toulmin [1958], ethical decision making could be usefully conceived as learning to appreciate and give good reasons for selected courses of action. He made reference to the reasonableness of drawing on standards of professional practice in fields such as engineering and the efforts of moralists to convert ethical possibilities into practical policies. As noted previously, this orientation toward practical utility was given enhanced articulation in an argument praising biomedical ethics for moving ethics away from abstractions toward situations, needs, and interests; emphasizing cases; and relating these cases to traditions of professional practice [Toulmin, 1982].

Appropriately enough, however, what constitutes applied analytic ethics has itself been subject to analysis, and thus became another contentious issue in need of conceptual clarification. Although the applied turn originated with efforts to bring ethical theory to bear on practical problems associated with technology, it was quickly discovered that abstract theory was seldom directly useful. In many cases it was irrelevant. What functioned better were mid-level principles that could enter into mutually informing dialogue with particular problems. Extending the movement toward the particular, Toulmin and others thus undertook to revive the tradition of bottom-up, case-based casuistry [Toulmin and Jonsen, 1988]. The theory behind such an approach argues for understanding moralities as social artifacts or institutions functioning as basic elements of a culture that must be appreciated as such — that is, in terms of the ends they serve and their historical evolution. Contextualism — and appreciation of the different contexts created by different technologies — thus becomes a primary pathway into analytic ethical reflection.

Although each of the contextual domains of reflection in the analytic ethics of technology is marked by its more or less unique discourse, it is nevertheless possible for synoptic purposes to identify four overarching themes falling into two broad areas. In the spirit of the analytic school itself, however, these themes remain no more than weakly linked. The broad areas are those having to do with (1) issues of justice and equity and (2) autonomy and liberty. Certainly it is the case that modern ethics and politics have repeatedly manifested opposing arguments for the primacy of equity or fairness and associated notions of solidarity and community (John Rawls) versus a stress on individual rights, private property, and near anarchic liberty (Robert Nozick). With respect to the first nexus of values, it is also simply an observational fact that justice and equity issues concerning technological benefits and harms relate to such key concepts as (1a) human health, safety, information, privacy, and risk and (1b) human and non-human welfare in relation to concepts of environmental pollution, obligations to nature, and sustainability. With respect to the second value perspective, it is again a matter of fact more than logic that the relation between technology and personal autonomy or liberty has been discussed especially in relation to themes of (2a) technical professional or producer responsibility and misconduct and (2b) public consumer or citizen participation in contrast to technocratic expertise. On the basis of such observations, Table 2 makes an analytic effort to summarize the basic issues manifest in analytic progressivism, with attention drawn as well to some of the key positive and negative concepts at play in the different contexts.

Table 2. Themes in Analytic Approaches of Technology

Concept modality / Area of concern	Benefits and Goods	Harms, Actual or Potential
General issue (1)	Justice and Equity in relation to	
(a) Humans	Health and Safety	Risk
	Information	Loss of privacy
(b) Non-humans	Environment / Sustainability	Pollution
General issue (2)	Autonomy and Liberty in relation to	
(a) Technical professionals	Responsibility / Integrity	Fraud and Misconduct
(b) Public consumers and citizens	Participation	Technocratic Expertise

3.4 Analytic approaches II: selective specifics

Historically, social justice issues arose in relation to the distribution of technological goods and services, and have exhibited a movement from concern for the fair distribution of positive benefits among humans to an emergent concern for negative impacts on animals and eventually the environment. Any number of analyses of overlapping efforts at conceptual clarification and application linkages related to health, safety, privacy, risk, environmental pollution, and sustainable development are characteristic of this theme cluster.

Kristin Shrader-Frechette, for instance, has argued that virtually the whole question of ethics and technology can be subsumed under various aspects of risk analysis: how to define risk, how to evaluate technological uncertainties, threats to due process from non-compensatable risks, risk assessment methods, the determination of socially acceptable risk (or safety), and consent to risk. Stimulated by ethical questions concerning nuclear power and public policy [Shrader-Frechette, 1980], she defends extending the concept of free and informed consent from medicine to technology in general [Shrader-Frechette, 1991]. Persons should be subject to technological risk only on the basis of intelligent personal assessment of those risks and choices not unduly constrained by economic pressures. Indeed, in the spirit of populism she maintains that laypersons are often more rational in their assessment of risks than experts (see Hansson's chapter "Risk and Safety in Technology" in this Volume, which clarifies how questions of risk have expanded well beyond issues related to nuclear technology.)

As exemplified in the domain of environmental ethics, the analytic approach again began with efforts to clarify rather high-level concepts such as environment, nature, pollution, wilderness, ecological systems, and sustainability. Although initially reflecting a top-down emphasis on distinctions between anthropocentric and non-anthropocentric (or biocentric) theories, extrinsic and intrinsic values, and arguments for obligations to future generations and the rights of nature, the analytic ethics of technology and the environment has evolved toward more contextualized interests in working with ranchers, farmers, forest and park managers, and even tourists and urban consumers to clarify interactions between their evolving social moralities and trans-human environments transformed by human technology. An example of this "policy-turn" in environmental ethics can be found in Adam Briggle's analysis of the controversies surrounding the proposed wind farm in Nantucket Sound [Briggle 2005].

Related bottom-up analyses have taken place in the domain of business ethics to reflect on the extent to which protection of an environmental commons and the ideal of sustainability might legitimately limit private ownership or entrepreneural technological actions. Taking analytic questioning into the context of computer and information technologies development, it is also useful to consider how access to information technologies should be facilitated under democratic capitalist structures. What are the parameters of intellectual property rights in software design, digitized information, and genetic engineering? From their technological beginnings such ethical issues of distributive justice have bedeviled welfare and public choice economics in relation to advanced communications technologies and called for more careful analysis than had previously been the case.

Closely related to the issues of health, safety, risk, pollution, and privacy are interdisciplinary efforts at technology assessment (TA), which was pioneered in the 1970s in the United States but then became more firmly institutionalized in Europe in the following decades. (See also Grunwald's chapter "Technology Assessment: Concepts and Methods" in this Volume.) Concern initially focused on technologies with unintended consequences which, if they had been appreciated, might have altered their economic adoption or utilization. What rapidly became apparent, however, was that many such non-desired (and even desirable) consequences were largely subject to probabilistic rather than to deterministic calculations, and that even the articulation of the probabilities was subject to value influences. This led to arguments for greater public participation in technical decision making and for the introduction of the perspectives of the social sciences and the humanities into science and technology policy [Frodeman and Mitcham, 2004].

A second general area of analytic work related to ethics and technology has focused on questions related to autonomy and liberty in relation especially to the exercise of technological power by technical professionals and the general public. Historically, advances in technology have both increased human freedom and diminished it; industrialization increased the power and influence of capitalists and reduced the autonomy of workers. According to one interpretation by Dewey, the idea of individual dignity that grew up in a Christian religious provenance was given "a secular and worldly turn" by the Industrial Revolution [Dewey, 1930, p. 75]. For Dewey, however, a concept that once separated human beings from their social context and in secularized form thus promoted practices of innovation and entrepreneurship among mechanics such as James Watt needs, as a result of the new context created by their industrial prowess, to be given a more social interpretation. Indeed, one can detect such a trajectory from atomistic to socialized individualism in the history of utilitarianism from Bentham to Mill.

With respect to the values of personal autonomy and liberty there have also emerged needs for conceptual clarification. In particular, there are a number of problematic dimensions to the exercise of such values by technical professionals or consumers. One general challenge is what David Collingridge [1980] called the dilemma of the social control of technology. In the early stages of a technology, when individuals might exercise some free control with relative ease, there is frequently insufficient knowledge to do so; by the time better understanding of the costs or risks is available, control has become difficult if not impossible and the exercise of personal autonomy has become highly constrained. David Rothman [1997] has described the same phenomenon in terms of an emergent technological imperative in the U.S. healthcare system and Daniel Callahan [2003] as a techno-scientific research imperative that can mold human dignity so that citizens as patients are convinced against what would most likely be their better judgments to make excessive investments in scientific projects with little prospects for a cost-effective return. In response to what has become known as the "Collingridge dilemma," Collingridge argued for careful assessment and the adoption of technologies that are themselves explicitly designed for flexibility. Other efforts to reconstruct opportunities for the exercise of practical autonomy have included constructive technology assessment [Schot, 2001], real time technology assessment [Guston and Sarewitz, 2002], values sensitive design ([Friedman *et al.*, 2006] and van de Poel's chapter "Values in Engineering Design" in this Volume), and "mid-stream modulation of technology" research and development [Fisher *et al.*, 2006] — all of which constitute proposals to overcome the dilemma by inserting ethical and political reflection at points that are neither too early nor too late. In the context of biomedicine there have likewise been complementary efforts to conceptualize the exact parameters of free and informed consent, and then to propose ways to institutionalize them. With regard to information technology, ethical analysis has attempted to clarify the meaning of privacy and security in the use of computerized databases and freedom of speech on the internet.

Responsibility in the technical professions constitutes one of the most widely analyzed themes in the analytic tradition. Responsibility in this context assumes moral accountability in the formal sense (sufficient knowledge plus free agency) but seeks to outline guidelines for the exercise of a producer morality beyond economic self-interest or social demand. The aim has been to construct a bridge between the exceptional powers of new technologies and accepted societal values. As will be referenced in more detail in the following section, one common position is that sketched by Stephen Unger [1994] in relation to engineering: engineers have a responsibility not only to their profession but to the general welfare. The formulation (or re-formulation) of codes of conduct for technical professionals has been one attempt to operationalize such notions of responsibility (see also Pritchard's chapter "Professional Standards for Engineers" in part V of this Volume).

Paul Durbin [1993] argues, however, that living up to the full measure of techno-professional responsibility often requires techno-professionals to step outside their professional roles and take public action in the larger techno-social world. For instance, techno-professional responsibility to protect consumers and users of technical goods and services through the formulation and enforcement of health, safety, and advertizing standards is not possible without involvement on the part of technical professionals. Occasionally such involvement has included public protest, as when physicists during the 1950s and early 1960s lobbied for a world-wide ban on the atmospheric testing of nuclear weapons or computer scientists in the 1980s opposed funding of the U.S. Strategic Defense Initiative (see [Mitcham, 2003]).

Extension and intensification of notions of producer responsibility and consumer autonomy easily shades into the issue of public participation in technical decision making, with its tensions between expertise and democracy. Responses to this problem are both practical and theoretical. An example from practice is the Center for Working Life established in the mid-1970s by the Swedish Parliament to allow Swedish workers to participate in the organization of work processes, especially as they are affected by scientific and technological change. The most well-developed theoretical analysis of the tension between technical expertise and democratic participation in decision making can be found in Robert Dahl [1985], who focused on the issue in relation to the control of nuclear weapons. In earlier work, Mumford [1967-1970] and Illich [1973] questioned the abilities of modern technological structures to facilitate social interaction, a topic that has been further pursued by Winner [1986] and Sclove [1995]. But in this area especially particular analytic analyses raise general or global criticisms reminiscent of phenomenological perspectives.

4 ETHICS SHAPING TECHNOLOGY

Adopting a distinction between ethics and morality — in which ethics constitutes a theoretical perspective on beliefs and practices, which by means of criticism in some measure also influences them — it can readily be argued that all three reflective approaches have informed the shaping of technology both directly and through the mediation of moral practices. Most directly, they have done so by expanding awareness, prompting critical thinking, clarifying concepts, as well as formulating and reinterpreting principles or guidelines for action. The fluidity of the ethics/morality distinction is nevertheless manifest in the fact that when such moral guidelines are institutionalized in professional practice they are commonly termed a kind of ethics. Such ethico-moral shaping of technology has occurred in at least three often overlapping spheres: professional, personal, and governmental. For analytic purposes, however, the three levels may be disaggregated.

4.1 Professional ethics shaping technology: biomedicine

As has previously been indicated, biomedical ethics and engineering ethics are two of the more prominent versions of applied ethics; in both fields, as well, ethical reflection has strongly engaged with the morality of professional life so as to influence technological practice. Indeed, so prominent is this with regard to biomedicine — which is not always fully recognized as a kind of technology — that biomedical ethics (also called bioethics) is the most intensively developed form of the applied ethics with the most technological influence. Yet precisely because the extensive literature on biomedical ethics does not always intersect with discourse on the ethics of technology and the engineering sciences, it deserves highlighting here.

As Edmund Pellegrino [1993] has observed, a historico-cultural metamorphosis of medical ethics into bio- and biomedical ethics took place during the 1970s. Until this period, professional medical ethics remained within a 2500-year old Hippocratic tradition, more or less independent of professional philosophy. On the basis of an oath to help the sick without causing harm, not to cause abortions, to lead a pure life, not to perform surgery or have sexual relations with patients, and to preserve patient confidences, medical morality strongly informed a relatively autonomous community of technical practice. This premodern shaping of the physician-patient relationship also evidenced a stance of humility before nature that endorsed pursuit of a human-nature harmony.

For Hippocrates, the aim of medicine was "preserving nature, not altering it" (Hippocrates, "Precepts," 19), and the physician had an obligation to "refuse to treat those overwhelmed by disease, since in such cases medicine is powerless" (Hippocrates, "On *techne*," 3). This ideal of working with nature found further expression in Aristotle's distinction between cultivation and construction: that is, between the *technai* of agriculture, education, and medicine, which assist nature in the realization of qualities that would appear to some degree independently of human action, versus such *technai* as carpentry, which introduces into nature forms that would not appear without human intervention (see, e.g., *Physics* II, 1, 193a12-17; *Politics* VII, 17, 1337a2; and *Oeconomica* I, 1, 1342a26-1343b2). The notion of the physician as one who cultivated health with quite limited technical means was allied as well to a paternalistic not to say authoritarian model of a profession that limited patient autonomy.

During the mid-twentieth century, the Hippocratic tradition was challenged by basic changes in society and in medical science and technology. World War II, for instance, produced not only the atomic bomb and a resultant need to develop ethical policies for its design and delimited use (e.g., fail safe triggers and deterrence theory) but also a dawning realization that expanding medical power (this was the first war in history where more soldiers died from combat than from infection and disease) might well call for new forms of moral guidance. As if to reinforce the point, the Nuremberg War Crimes Tribunals (1945-1949) disclosed the failure of the Hippocratic tradition in that some members of the medical profession in Germany abused their authority by conducting radically immoral human experimentations — a discovery that led to formulation of the Nuremberg Code to protect human subjects. In succeeding decades, advances in medical science (altered by alliances with psychology, molecular biology, and other life sciences) and in medical technology (e.g., the engineered invention of new means of birth control and abortion as well as heart-lung, dialysis, and other life-extending machines) transformed medicine into biomedicine and overwhelmed the ideal of cultivation in favor of systematic construction and control.

New moral or professional ethical guidelines for the treatment of human subjects were initially imposed on biomedicine from without. But the biomedical community quickly made them its own, and between the 1960s and 1980s increasingly collaborated with applied ethicists to further re-envision technomedical practice. Physician Henry Beecher, for instance, in the Belmont Report, documented how medical researchers in the United States — in multiple less flagrant but nonetheless serious cases — pursued technoscientific knowledge via human subjects experimentation deeply deficient in respect for human dignity [Beecher, 1966]. In response, the biomedical profession itself, admittedly against some internal resistance, undertook to develop stronger protocols and to strengthen institutional mechanisms for their enforcement. In multiple instances expanding awareness of real practices prompted critical thinking and the ethical reshaping of technical practice.

This ethical shaping of the technology of medicine took place in a series of overlapping stages. The first, during the 1960s and 1970s, featured broad philosophical reflections similar to those found in the historico-critical approach. For instance, Reiser [1978] examined how since the nineteenth century medical diagnosis technologies — from the thermometer and stethoscope through x-ray machines to electromagnetic resonance tomography — had increasingly diminished direct physician-patient contact and thus dehumanized medical practice. Involvement by theologians and various Christian religious traditions was another distinctive feature of this early period.

In a second stage, during the 1980s and 1990s, the ethical shaping of biomedicine became both institutionalized and increasingly analytic. The so-called Georgetown University school of bioethics, for instance, developed a series of principles — nonmalfeasance, beneficence, respect for autonomy, and justice (see [Beauchamp and Childress, 1979]) — that were taught in large numbers of continuing education workshops for physicians. The second period also witnessed stimulation by case studies and, perhaps as a result, concentration on specific issues such as the redefinition of death (in the presence of heart-lung machines that could substitute indefinitely for a patient's own failed organs) and guidelines for the proper practice of human cloning (after the 1997 announcement of the cloned sheep Dolly).

The early 2000s witnessed emergence of a third stage, in reaction against the alleged narrowness of the second. Led by such scholars as Leon Kass there was an effort once again to enlarge bioethics to take on the big questions of human meaning and the good life in ways that echoed socio-critical concerns. As chair of the President's Council on Bioethics in the first term of President George W. Bush, Kass [2003] questioned biotechnological aspirations to biomedically engineer better children, enhanced performance, ageless bodies, and happy souls. In addition, in the name of defending human dignity, he helped formulate restrictions on the federal funding of human embryonic stem cell research. Indeed, in one quite remarkable instance of the ethical shaping of biomedical research technology, this limitation promoted development of stem cell technologies employing non-embryonic tissue. In opposition, transhumanists such as computer engineer and inventor Raymond Kurzweil [2005] enthusiastically endorsed the use of biomedical technologies for a wide array of enhancements, provided the initiative came from a bottom-up consumer base rather than top-down governmental decision. Biomedical change thus stimulated and was itself stimulated by ethical arguments between competing concepts and guiding principles.

4.2 Professional ethics shaping technology: engineering

Another instance in which ethical reflection strongly engaged professional life and in the process gave distinctive shape to technology can be found in engineering more broadly understood. Here the collaboration of technical professionals has been primarily with ethicists representing analytic approaches. From the last third of the twentieth century, as a result of unique social circumstances, this was especially the case in the United States, as engineers struggled for professional recognition in ways that included the development of professional codes of ethics — codes that dialectically reflected and helped mold engineering practice.

Engineering as a distinctly modern discipline did not originate until the late 1700s, and it began by needing to play catch-up in growth as a profession. The classic professions of medicine, law, and theology were already well established social institutions that from the beginning engineering aspired to imitate. The prehistory of engineering can be traced back to military personnel who designed and operated "engines of war" and fortifications. One example of the emergence of engineering from its military roots took place in France when, in 1716, state service was given civilian but highly regimented form in the Corps des Ponts et Chaussées, with subsequent establishment of the École des Ponts et Chaussées (1747) for the more effective training of its leaders. This institution of higher education was followed by the École des Mines (1783) and the École Polytechnic (1794), the latter founded to support the French Revolution by Lazare Carnot and Gaspard Monge, two creators of the engineering sciences (see also [Didier, 1999]).

A complementary emergence took place in England when, in the late 1770s, John Smeaton took the title "civil engineer" (as opposed to military engineer). It was Smeaton as well who organized an informal dining club as a kind of non-governmental organization called the Society of Civil Engineers (later called "Smeatonians"). The Society of Civil Engineers morphed in 1818 into the Institution of Civil Engineers, which in 1828 was granted a Royal Charter. The British model of non-governmental organization became the pattern for professional engineering organizations in North America. Historian Edwin Layton (1971), for instance, has described in detail how engineers in the United States, unlike physicians, struggled with professional divisions into civil engineers, mechanical engineers, electrical engineers, and a host of other discipline and class delimited groups. The American Society of Civil Engineers (ASCE, founded in 1852) was an elitist organization often at odds with business interests. The American Institute of Mining Engineers (AIME, founded in 1871), by contrast, was more egalitarian and allied with business. Different mixes of autonomous professionalism and commercial pragmatism characterized such subsequent organizations as the American Society of Mechanical Engineers (ASME, 1880) and the American Institute of Electrical Engineers (AIEE, 1884). But none could escape the fact that most U.S. engineers were employees of large firms that benefitted from engineering fragmentation, in opposition to the professional autonomy enjoyed by self-employed physicians.

In response to the forces of division there emerged a series of efforts to unify the professional engineering community, one aspect of which involved attempts to formulate professional ethics codes that might articulate a common engineering ideal of public service. The classic definition of the defining activity of the profession, that of the British engineer Thomas Tredgold (1788-1829), described engineering as "the art of directing the great sources of power in nature for the use and convenience of man." But in comparison with the ideal of health that animates the practice of medicine, "use and convenience" was subject to determination more by employer or client than professional.

One inadequate effort to escape such conceptual subordination with the articulation of an ideal that would justify engineering professional independence focused on efficiency, an approach promoted by the technocracy movement [Akin, 1977]. But efficiency as an engineering ideal has a complex history (see Alexander's chapter "History of the Concept of Efficiency" in this Volume) and was problematic on two counts. It elevated technical expertise over public decision making and was therefore at odds with commitments to both democracy and the marketplace. Moreover, as a ratio of outputs over inputs, efficiency remained context dependent — thus still subject to multiple interpretations, depending on how inputs and outputs themselves were defined, with the relevant determination usually being made by non-engineers.

To side step the technocracy dilemma, engineering ethics codes simply resorted to stressing a generalized public service ideal. The most common formulation became the statement that engineers have an obligation to hold paramount the protection of public safety, health, and welfare — or what is often called a "paramountcy clause" (see, e.g., the "Code of Ethics for Engineers" of the National Society of Professional Engineers, founded 1934). Initially engineering codes had highlighted professional loyalty — especially loyalty to a client or employer. For instance, the 1914 code of the ASME made the first duty of the engineer to be a "faithful agent or trustee" of some employing client or corporation. Although Michael Davis [2002] has contested a too literal reading of this requirement, the ASME Committee on Code of Ethics (1915) in a contemporaneous commentary emphasized "protection of a client's or employer's interests" as an engineer's "first obligation." At the same time, the ASME code counseled engineers "to assist the public to a fair and correct general understanding of engineering matters." Across the twentieth century such counsel, together with later commitment to the paramountcy clause, forced engineering educators repeatedly to confront the difficulties of communicating to engineers a broad conception of their professional responsibilities and best practices for public communication.

Post World War II, with special vigor during the 1970s, engineering ethics codes in the United States became subjects of extended discussion and revision in order to address issues raised by the increased importance of engineering in the social order and public concern about a number of specifically technical disasters, including environmental problems implicating major engineering projects. Well-known disasters included two major DC-10 crashes (Paris in 1974 and Chicago in 1979) and a large number of fatal accidents with the Ford Pinto automobile (manufactured from 1971 to 1980), both associated with problematic engineering designs that companies refused to correct even though engineers had called them to attention. From the 1960s on debates have multiplied concerning the environmental impacts of U.S. Army Corps of Engineers projects, from dams on the Colorado River to Everglades wetlands management. Such experiences led to the profiling of "whistle blower" as a moral-technical hero who transgresses company loyalty to expose threats to public safety, health, or welfare.

To this historical juncture, arguments regarding engineering ethics took place largely below the radar of professional philosophy. This is not to say that they lacked philosophical significance and as such could not be referenced to argue the ethical shaping of technology, only that they failed to engage the professional community of academic philosophers. In an effort to overcome this hiatus and to promote further conceptual clarification and principle formulation, the U.S. National Science Foundation thus undertook to fund collaborative research between philosophers and engineers to better analyze engineering ethics issues — such as those associated with whistle blowing, autonomy, and the "paramountcy clause" — and to develop appropriate materials for teaching engineering ethics. This led to efforts such as one by philosopher Michael Martin and engineer Roland Schinzinger [1983] to explore the extension of the biomedical principle of free and informed consent to engineering. When the *Challenger* shuttle disaster of 1986 further exposed weaknesses in engineering independence, it stimulated discussions that led by 2000 to explicit requirements for any accredited engineering curriculum to include the teaching of engineering ethics. Beyond this, Carl Mitcham [1994b] argued for a review of the case studies that had most contributed to the evolutionary trajectory of professional engineering consciousness implied a new obligation *plus respicere* for engineers to move beyond personal responsibility and to take into account more than the technical dimensions of their work; and Davis [1998] advanced a philosophically sophisticated analysis of engineering ethics codes arguing they be understood as analogous to technical standards and thus as functionally binding — that is, in effect, to integrate technology and ethics in professional practice.

Although the ethical shaping of engineering in the United States took place absent dialogue with discussions in other countries, the problems with which North American engineers had to deal could not help but transcended national boundaries. From the late 1980s on, engineering ethics outside the United States progressively provided complementary analyses while profiting as well from U.S. developments. To cite a spectrum of examples: In the ethics codes of Canadian and Australian engineering societies it is possible to find variations on the non-governmental organization model for professional engineering that originated in the British Isles, while state sponsored promotions of engineering professionalism in Latin American countries shared some of the approaches found in the French model. In Germany engineering ethics, influenced by efforts to compensate for the complicity of engineers with National Socialism, came to exhibit a much more systematic and philosophical form (see [Mitcham and Huning, 1994]). Some developing countries, such as the Dominican Republic, have used engineering ethics codes to criticize persistent patterns of corruption. In Hong Kong codes were created to buttress autonomy in anticipation of the reversion of a colonial outpost to governance by China. In three transnational professional engineering associations — the Pan American Federation of Engineering Societies (UPADI, founded 1949), the European Federation of National Engineering Associations (FEANI, founded 1951), and the World Federation of Engineering Organizations (WFEO, founded 1968) — can be found some of the strongest efforts to promote environmental responsibility as elements in engineering ethics. (For further review with a documentary collection of codes, see]Mitcham, 2005].)

Finally, it is important to note that the ethical shaping of engineering is itself shaped by the historical and social contexts of different engineering cultures. Such recognition, stimulated by the development of interdisciplinary scholarship in engineering studies (see [Downey and Lucena, 1995]) draws on the approaches to ethical reflection present in the socio-critical and historio-cultural schools of ethics and technology. As has been argued in a case-study comparison of engineering ethics in France, Germany, and Japan, different issues can influence the kind of interest engineers and engineering educators take in engineering ethics.

> A key variable is the relationship between the identities of engineers, e.g., what it means to be an engineer and who counts as an engineer, and the responsibilities of engineering work, including technical responsibilities. The contents of this relationship have varied significantly over time and from place to place around the world. As a result, when one inquires into who has counted as engineers, and what has counted as engineering knowledge and engineering responsibilities at different times and places, the relatively straightforward questions . . . become significantly variable in meaning and attract remarkably diverse answers [Downey *et al.*, 2003, p. 465].

With regard to the cases at hand, engineering ethics is of little interest in France because of the integration of engineering and civil service. In Germany engineering ethics has been integrated into a broad philosophical reflection on engineering. And in Japan, a rise of interest in engineering ethics can be linked to a decline in the extent to which corporations no longer function as "households." In a globalizing world it must still be recognized that similar challenges can nevertheless have "variable significance and manifestations [depending on] how these challenges are internalized" [Downey *et al.*, 2003, p. 482], even when the interpretations of particular internalizations can be contested.

4.3 Personal shaping: consumers as producers

Professional ethics has become integral to the practice of biomedicine and engineering and thus given them historically distinctive characters. Never before in the history of these professions have ethics and philosophy been so influential on their moral codes and thereby on the technical professions themselves, their practices and products. Equally important, however, is the degree to which not just professionals but consumers and their moral concerns, also molded to some degree by popular ethical reflections, have exerted subtle influence over the shapes of technological processes and products. Patients have themselves influenced the ethics of biomedicine and consumer users, through their approvals and their rejections, have modulated the mix of engineered products.

To appreciate the moral shaping of technology, it is not enough to consider a physical object, technical process, or intended function as conceived and designed within the technical community. When an artifact emerges from the laboratory, it shifts from being a predictable and insular entity in a controlled context and becomes simply one more element in a complex, uncontrolled, and interactive social network. When a television is turned on, a series of predictable electromagnetic processes occur that leads to the generation of an image. Outside the functioning of the electronic device itself, however, little if anything is predictable, because further attributes derive not from physical laws but from the socio-cultural networks into which it is deployed. What is being broadcast to whom, when, and where? What activities do viewers forego in order to watch television, and how does this impact the character of society and quality of life? Even more important, what do viewers make of what they watch?

For the cultural anthropologist Michel de Certeau, watching television is misunderstood if seen only in terms of passive consumption. Watching and the inevitable reacting to television constitutes a second order productivity — a first order being that of engineering the artifact and creating the programmatic content, the second order taking place with the always creative receptivity of the viewer. According to Certeau,

> the analysis of the images broadcast by television (of representations) and of the time passed sitting in front of them (a behavior) must be complemented by the study of what the cultural consumer "*makes*" or "*does*" [*fabrique*] during these hours and with these images. The same

> goes for the using of ... the products purchased in the supermarket. [Certeau, 1980, p. 11]

For Certeau it is necessary to distinguish between the strategies of primary production that create powerful institutions and the tactics that ordinary people use in everyday life to carve out niches for themselves within those institutions, as when workers subtly appropriate the workplace to make things for themselves or renters repaint apartments in non-approved colors, in both cases transforming the technological milieux presented to them in predetermined shapes.

As consumers, operators, and citizens, people make choices about the technologies they use and how they use them, and these choices influence as well the behavior of markets and governments. Consumers may choose, for example, to purchase a hybrid vehicle, a sports utility vehicle, or forego a personal automobile in favor of using the bus or train. Parents make decisions about what media content and which communication technologies are appropriate for their children. Acting as citizens, on the basis of their own informal ethical reflections, people lobby their democratic representatives to pursue one energy production strategy or another. Consumers and citizens, either consciously or not, weigh risks, costs, and benefits to form judgments that guide their uses of artifacts and systems.

In a world in which the family, religion, and other traditional structures of popular morality have become attenuated, while the stakes of making and using artifacts have only become increased, common experience becomes increasingly ethicized. The ethics/morality difference itself diminishes as people are forced to think for themselves. For Charles Taylor [2007] this is the key feature of the modern secular age. Morality ceases somewhat to be morality and, just as is the case with professional life, reaches out and becomes receptive to philosophy so that quotidian experience becomes infused with ethical reflection. Adapting the suggestive argument of Lorenzo Magnani [2007], in the technological world morality might almost be said to have a duty to become ethics.

That ordinary individuals thus reflecting on their beliefs and behaviors have a degree of leeway in shaping technology is significant. This is especially so in terms of assigning responsibility for accidents and failures. It is particular drivers, for example, who start automobiles and drive them carefully or not down city streets. Although engineers design and develop the use plans for cars, these are like seeds that sprout and flourish differently under different conditions. Drivers are the ones who provide the conditions that "bring cars to life." When an intoxicated driver has an accident, the default assumption is that the driver is responsible, although if the accident resulted from a steering wheel coming loose from the steering column because of a design flaw in the pen connector, the engineer or manufacturer might be charged with responsibility. Lines between designers and users, however, are not always clear. This is especially the case with open source software and "share and share alike" software licenses that allow users to alter code or contribute content collectively. Such developments have blurred distinctions between the technical producer and consumer, giving rise of the concept of the "prosumer" (producer-consumer).

A key question raised by the consumer shaping of technology thus concerns the level of freedom and responsibility that people really have in working out their personal technological existences. What is the range and quality of decisions they can make? Robust answers will depend on context, the interpretation of which will nevertheless easily be influenced by general beliefs about the neutrality of technology. The neutrality thesis as a principle of the popular ethics of technology argues that insofar as technologies express values these are values of effectiveness with respect to a given function (see also Radder's chapter "Why Technologies Are Inherently Normative" in this Volume). Artifacts are otherwise neutral with respect to the wider practices and contexts in which they are deployed. They are objects that can be put to good or bad uses by good or bad people, because there are always multiple ways they can be used. As the saying goes, "Cars don't drive themselves."

There is obviously some truth to this thesis, but the situation is more complex than it would seem to admit; a society with cars is different than one without. When an automobile sits in the driveway, it takes a special act of the will for its owner to walk five blocks to the store. A simple decision to purchase groceries would likely take on a quite different trajectory than the same decision absent the presence of the car. Although artifacts and systems do not possess agency in the standard sense, they do structure the human lifeworld so as to transform situations and options available to their inhabitants.

Another aspect of technological non-neutrality has been conceptualized in the notion of a technological "script." Like a dramatic script, a technological one prescribes behavior to some extent while allowing actors to make diverse interpretations in their performances [Bijker and Law, 1992]. Another related concept is that of "value suitabilities." A given technology may well be "more suitable for certain activities and more readily [supporting of] certain values while rendering other activities and values more difficult to realize" [Friedman *et al.*, 2006, p. 351]. At the same time, the culture in which technological scripts exist will make their own contributions to use. Although "Cars don't drive themselves," the people in one country with cars may be strongly influenced by a culture that nevertheless inhibits their use by taxes, road design, or more informal social expectations. The degree to which a person's morality, even when ethicalized, will be able to influence the shape of technology may be somewhat marginal. Is it possible that Certeau romanticized the productivity of the consumer?

Technological cultures "confront people born into them not as something they may freely choose to adopt if they wish, but as an *imposed given* imbued with great inertia" [McGinn 1991, p. 75]. After all, most people in many parts of the advanced technological world cannot choose to live without cars, television, the internet, or related artifacts — or in cultures that enact these artifacts in particular ways. The question of freedom must confront the fact that the human subject is always already a subject-in-the-technoworld. From such a historico-cultural perspective, individuals can only achieve a free relation to technology once they realize the extent to which their world and consciousness are technologically mediated. To achieve a free relation with technology is as difficult as achieving a free relationship with one's parents or one's religion. Some people do it, but not without effort. Even the simple truth, often argued with an analytic approach, that technologies which open doors almost always close others, is difficult to appreciate at the existential level.

Thinking about how individuals or groups of non-technical consumers shape the technological world in which they live raises anew the issue of responsibility for unintended consequences and externalities such as air pollution, climate change, species extinction, or groundwater depletion. Can any individual user be considered morally accountable for such phenomena? Such collective problems emerge as a result of individuals each fulfilling quite restricted social roles and associated responsibilities. Problems result from the sum total of millions of people performing simple actions, from driving cars to watching television, none of which alone may have any significant effects. Although individuals may be able to mitigate these problems to some degree, and could even be argued to have a meta-role responsibility to bring ethical reflection to bear in technological societies, in the absence of dramatic events, not everyone can be expected to practice what may be experienced as supererogatory virtues. More importantly, individuals acting on their own are fundamentally restricted in terms of the changes they can effect. Problems are systemic, that is, are the result of entire technological networks such as transport and industrial agriculture. Beyond marginal refinements, individuals as such cannot alter the systems they have created. Serious change requires collective or political action.

4.4 Political shaping: regulation and promotion

Since the late-nineteenth century, nation states have matched the increasing complexity of material culture with a growing bureaucracy. Technologies create both expected and unexpected health, safety, environmental, and socioeconomic benefits, risks, and responsibilities. Governments grow and adapt in efforts to defend and apply received moral traditions to new situations. The relationship between law and ethics, however, is not a straightforward matter of application. Though many laws are a direct social embodiment of some ethical principal (e.g., laws protecting minors from sexual predators on the internet), some laws are motivated by pragmatic needs rather than directly by ethics (e.g., laws that coordinate government agencies). Furthermore, laws can be unjust or otherwise unethical, at least from the perspective of certain moral theories. This is clearly the case, for example, with laws permitting slavery and discrimination based on race and gender.

Laws and regulatory agencies together with promotional policies shape technology in ways that are often more potent and direct than either technical professionals or consumer users. Although historio-cultural reflections sometimes interpret the emergence of such bureaucratic agencies as themselves expressions of modern technology, analytic and socio-critical reflections are more likely to see them as ways morality and associated ethical analyses influence technology.

It is thus analytic approaches, together with modest contributions from socio-critical approaches, that have been most engaged with political and legal institutions. The law, as enacted by legislatures (statutory law) or executive agencies (administrative law) and then interpreted by the courts, is the primary mechanism for the political shaping of technology. Legal activities and the policies they manifest fall into the two broad categories: down-stream regulation and up-stream policy guidance. Regulation involves the creation of standards — for construction (building codes), foods and drugs (health and quality standards), transport (operating criteria), environmental protection, advertising, etc. — that rely crucially on scientific and technical knowledge [Jasanoff, 1995]. Regulation seeks both to reduce risks *ex ante*, before they are imposed, and *ex poste*, often through litigation after risk exposures have occurred. Guidance policies in turn seek to directly fund or provide indirect tax and related incentives for one technology over another, thus influencing the types and mixes of technological products, processes, and systems. In undertaking such activities, the law plays a critical role in fostering innovation and selective development, sometimes focused on special regions or groups, and in further distributing the public and private goods benefits of technology.

Feenberg [2002] explores the notion of "technical code" to demonstrate how governmental regulation can shape technology at basic levels. Technical codes reveal how technical parameters are socially constructed. For example, by 1852, 5,000 steamboat passengers in the U.S. had died as a result of boiler explosions. The U.S. Congress awarded its first federal grant to do technical research on the problem and then created an agency that mandated technical changes such as thicker walls and safety valves. Boiler design was shaped by social and political judgments about safety; ethics was literally "cast in iron." (Illustrating Certeau's user creativity, however, steamboat captains often disabled safety values in order to run at higher pressures and make better time.) The same political negotiation is at work in the adoption of environmental standards, such as fuel efficiency requirements for automobiles, emission restrictions on power plants, or extended manufacturer responsibility. As values such as safety, sustainability, or justice become part of technical codes, they are treated as intrinsic features of the artifacts. They cease to be broken out as the specific "price" that an otherwise pure technical rationality must pay. Upholding these standards eventually becomes the law, not a "trade-off" with efficiency.

The regulation of technology raises a host of ethical issues. In analytic outline, it is possible to identify five main tensions that continuously occur: (a) conflicting interests between regulating agency and regulated industry; (b) relative benefits of regulation versus deregulation and market solutions; (c) tradeoffs between values such as safety and cost, security and free speech, or profit and environmental preservation; (d) jurisdictional disputes regarding the power to regulate, especially in transnational situations; and (e) disputes about which principles or goals ought to guide regulation. The last is particularly notable in debates concerning the meaning and desirability of the precautionary principle as a guide to the governance of technologies.

With regard to promotion, governments use a wide variety of mechanisms to encourage or direct technological innovation. Indeed, regulation often spurs innovation, as with automobile emissions standards, which forced automakers to develop and adopt new technologies. Other mechanisms include: (a) research and development; (b) subsidies; (c) loan guarantees for companies developing technologies — such as nuclear power plants — that require massive amounts of capital; (d) technology transfer legislation that promotes the flow of government-funded inventions to the private sector or the flow of technologies in industrial nations to developing nations; and (e) intellectual property laws that give inventors a time-limited exclusive right to commercially exploit the output of their work.

Adjudication of the tensions involved in regulation or decision making with regard to the mechanisms of promotion always involve moral judgments — judgments which are again increasingly enhanced by critical ethical reflection. Of particular salience have been questions concerning the just distribution of scarce resources and allocations of authority to manage technological change. Since such decisions and reflection upon them are made by individuals, ethico-moral shaping of technology at the political level inevitably implicates as well the personal and professional spheres. What for analytic purposes is separated, in the techno-lifeworld is a complex whole that can also be thought as a technological shaping of ethics.

5 TECHNOLOGY SHAPING ETHICS

Thus far the focus has been on how ethics has assessed and shaped technology — across historical periods; in different philosophical schools; and through moralities operative at the levels of professional life, consumer behavior, and political governance. Technologies have been considered primarily as objects and processes for ethical reflection and intervention. But at several points it has also been suggested that the interaction between ethics and technology could on occasion be reciprocal. If technology can shape society, which is not open to doubt, then why not as well the cultures, morals, and ideas that help make up a society? For example, the developments of birth control and in vitro fertilization (IVF) technologies in the 1980s were met initially with widespread moral and religious objections that nevertheless moderated over time.

Yet that technology might shape morality or ethics is more problematic than the ethical shaping of technology, because ethics is viewed by many philosophers as well as the public at large as an autonomous dimension of culture — perhaps even the most autonomous dimension. Indeed, for a modern philosopher such as Kant, to think of morality in heteronomous terms as determined by something other than itself is to fail to recognize what ethics really is.

In thinking about the possible technological shaping of ethics it may thus be useful to consider how even from a Kantian perspective modern science, a close associate of technology, can be admitted to have exercised a shaping influence on ethics. According to the Kantian ethical theorist Christine Korsgaard [1996], modern moral and political philosophy can be read as a series of responses to what she calls the modern scientific worldview. Prior to the rise of modernity, form and value were taken as more real than experienced fact. The form of a thing, even when not fully present in some particular, pointed toward and constituted its perfection. With modern science, however, the world came to be thought in terms of matter and energy, indifferent stuff acting according to universal laws. Under such circumstances, Korsgaard argues, "If the real and the good are no longer one, value must find its way into the world somehow. Form must be imposed on the world of matter" [1996, p. 5]. Modern science thus set the stage for and helped shape the rise of subsequent ethical theory.

Hobbes and Samuel von Pufendorf (1632-1694) were among the early philosophers to recognize the ethical challenge posed by the scientific worldview and in the process to become agents through which this worldview began to shape ethics. Both made the ethical argument that since morals are not to be found in nature, they must be created by human decisions. Kant himself, of course, sought to ground morality in the inherent rationality of practical decision making itself rather than simply in decision makers. But all three ethical theorists, insofar as they undertook to respond to a scientific worldview, allowed in ethics for a subtle shaping by science.

This indirect scientific shaping of ethics has perhaps been more widely appreciated than technological shaping — and yet the former surely suggests the latter. More boldly stated, Enlightenment philosophers attempted to use modern science to reshape ethics through its cognitive products (facts and theories) and its distinctive methods (experimentation and quantitative analysis). Scientific enlightenment sought to use factual knowledge to dispel illusion and myth, as in Galilean astronomy and Darwinian evolution, and to provide new forms of moral analysis, as with utilitarianism.

Taking such shaping as a suggestive template, technology can in like manner be thought of as able to influence ethics in four ways: (a) technology creates new moral issues and questions; (b) technology requires adjustments in morally significant concepts; (c) technology may require new moral theories; and (d) technology and technological concepts change our moral self-image and visions of the good life.

The first mode of shaping is perhaps the most obvious. When technologies change or new ones are invented a culture can become "maladjusted" or exhibit what sociologist William Fielding Ogburn [1964] called "cultural lag" (see also [Toffler, 1970]). After the introduction of the automobile, for example, it took time for the culture of roadway design to catch up, and new habits and expectations on the part of drivers had to be cultivated, eventually constituting a new morality operative within the transportation system. The widespread adoption of mobile phones has created new moral questions about the etiquette of their use in public spaces. The moral questions and issues involved in global climate change would not have arisen absent modern technologies.

Second, technological change can challenge the adequacy of morally significant concepts, perhaps demanding reformulation of those concepts. Advances in life-support technologies during the 1970s called into question traditional definitions of *death* in terms of cardiac or pulmonary arrest and led to another in terms of brain functioning. Advances in ambient intelligence, surveillance, and genetic technologies similarly challenge received notions of *privacy* and *personal property.* The environmental impacts of industrial technologies encouraged reconsideration of the concept of *wilderness*—what was once threat came to be conceived, under conditions of harried technological affluence, as sanctuary, and subsequently as itself threatened by industrial pollution. Similar industrial impacts led to the creation of *endangered species* as a new legal and moral concept and *environment* as a good to be protected.

The rise of computer-mediated relationships has promoted new interpretations of *community* and *friendship* (e.g., [Briggle 2008]) while computer simulation raises new questions about *reality* and its normativity [e.g., Borgmann, 1999]. Enhancement technologies suggest new considerations of *human nature* as they open doors to emergent post- or trans-humanist ideals [Bostrom 2005]. Indeed, modern technology has long been used as a source of images for thinking about human nature. In the 1600s, Hobbes asked, "For what is the Heart, but a Spring; and the Nerves, but so many Strings; and the Joynts, but so many Wheeles. . . ?" [*Leviathan,* introduction]

In some cases, technology expands the scope of moral concepts, reshaping the sense of the normal. For example, oil and electricity, once objects of desires only among the wealthy few, have become *needs.* They are necessary for survival for all in a society of mass affluence due to the technologies that require their input. From this perspective, technological development imposes new needs and higher levels of consumption on supposedly *underdeveloped* peoples. Suddenly, a villager needs a bus ticket, rental housing, utilities, and schooling [Escobar, 1995]. Technology not only expands needs but also *rights claims* [McGinn, 1991]. For example, the right to life was traditionally understood in negative terms — as an entitlement not to be deprived of life or physical integrity. But in the presence of life-preserving technologies, this right tends to take on expansive form — as an entitlement to be provided with whatever medical treatment is necessary to sustain life. In a similar fashion, clean water, vaccinations, and other goods and services become entitlements as technologies develop that can make them readily available.

Third, technology may not just destabilize or engender significant moral concepts but actually call for the development of entirely new moral theories. As noted above, there is disagreement on this point. Analytic philosophers tend to argue that existing theories are adequate, while some representatives of the other traditions disagree. Jonas [1984], for example, argues that modern technology creates the need for a new ethics in terms of theory and practice. Premodern ethics could allow technics to remain in the background as a marginal aspect of life. During the modern period technology entered the foreground of human experience at precisely the same time modern science undermined natural teleology and the notion of a stable human nature as a guide to its wise use. As a result, technology became "restless" in serving desires and creating needs. A "new conception of duties and rights" is required to take account of the global and intergenerational impacts of technology. Jonas saw modern technology as having "introduced actions of such novel scale, objects, and consequences that the framework of former ethics can no longer contain them" [1984, p. 6]. In place of consequentialism or deontology, Jonas proposes a new ethical imperative: "Act so that the effects of your action are compatible with the permanence of genuine human life" [1984, p. 11].

There are a number of other efforts to formulate ethical principles that would catch up or accommodate the technological transformation of the lifeworld. Mitcham [1994b], for example, has argued that engineers especially have a duty *plus respicere,* to take more things into account. Magnani [2007], more generally, has argued that in the presence of technology acting with knowledge becomes a moral duty. Lawrence Schmidt and Scott Marratto [2008] echo Jonas in arguing that there is no consistent ethical framework to deal with the long-range negative consequences of certain technological developments. They propose a post-liberal theory that rejects the ideology of progress in favor of caution and limitation.

Fourth, technology and technological concepts can alter our moral self-image. Technology not only introduces new material products and processes, it also conditions how these new realities will be conceptualized and evaluated. Humans are not just confronted with new needs, for example, but come to understand and assess themselves as beings in possession of needs who calculate their satisfaction. Humans come to conceive themselves, their goals, and their world partly through and in terms of technology.

In this regard, techniques of writing and reading are especially important. According to Walter Ong, for oral peoples judgment "bears in on the individual from outside, not from within" [1982, p. 55]. By contrast, the literate mind tends to stand abstracted from the concreteness of lived experience, which fosters greater introspective self-judgment. Illich [1993] further explored the importance of writing and reading techniques for patterning self and reality. In addition, Michel Foucault [1988] argued that different cultures utilize technics to engender different notions and experiences of the human self. Sherry Turkle [1995] argued that computers have ushered in a novel self-understanding. Nicholas Carr [2008] has picked up on this theme to argue that the internet alters the way humans read and think. Whereas books foster and demand the discipline to follow a sustained argument or narrative, the internet promotes a style of reading that puts efficiency and immediacy above all else. This alters the self, because humans are not only *what* they read but *how* they read (see [Wolf, 2007]). Indeed, the kind of media used in reading and writing actually shapes neural circuits and thus the kind of thinking self that emerges.

But the human self is configured not just through and in terms of media. Another example is medicalization, or the process whereby certain features of human life come to be defined and treated as medical conditions. With the advent of new medical techniques, certain conditions become diseases or disorders rather than, for example, curses or personality traits. This fosters a new and normatively charged self-conception. Some argue that the uncritical expansion of a medicalizing mindset — considering all occasions of sadness, anger, or regret as medical conditions — threatens to picture the human solely in biomedical terms rather than in psychic, spiritual, or moral ones [President's Council on Bioethics, 2003]. Medical terminology has also fostered a self-conceptualization in terms of risk. Illich argued that this is disembodying, because thinking in terms of risk is "an invitation to intensive self-algorithmization ... reducing myself entirely to misplaced concreteness by projecting myself on a curve" [Illich, 2005, p. 210]. A similar point could be made about the extension of the ideal of efficiency from the technical sphere into the lifeworld. In technological societies, activities that consume considerable amounts of time become targets for efficiency enhancement: thus, the rise of food processors, microwaves, word processors, household cleaning appliances, and electronic communication in place of handwritten letters [McGinn, 1991]. Yet there are dangers in understanding a family meal or correspondence between friends in terms of efficiency.

The patterning of the self by technology suggests that technology will also shape how that self conceives of flourishing or a good life. For example, television does not just satisfy preferences, but shapes and engenders preferences. Similarly, leisure — a component of the good life — is understood now in ways that are fundamentally shaped by technology [McGinn, 1991]. Industrialization has compartmentalized life into structurally differentiated spheres of activity, including work and leisure. Leisure has since taken on its own evolving values and forms in which technologies play a central role. The good life in a materially affluent world is widely conceived of in terms of the consumption and comfort afforded by technologies, which brings along its opposite, namely, increased anxiety about death and risks to physical well-being. This notion of the good life was not in ascendency in medieval European cultures that valued honor, bravery, and risk-taking above comfort and convenience. It is worth further considering the role of technology in such historical moral transformations.

Finally, the technological configuring of the good life raises two important questions that deserve further scrutiny. One is conceptual: Is "television-watching" or any new technology-based vision of the good life a new *type* of answer to the good life or simply a new *token* or species within a timeless category (e.g., passive entertainment)? That is, does technology create fundamentally new values or does it just shift — expand or contract — pre-existing categories of human valuing and activity? A second concerns whether values or schemes of preferences simply change and adapt to a changing technological lifeworld. If so, does this preclude normative appraisals of past and future worlds from our bounded perspective in the present? Are not the citizens of *Brave New World* (1932) leading debased lives, even though their schemes of preferences are perfectly adapted to a particular set of technological constructions?

6 CONCLUSION: ETHICS AND TECHNOLOGY INTERACTING

A summary statement of the thesis of this chapter might be that ethics and technology have, since the beginning of the modern period, increasingly influenced one another. One way to reiterate and take large-scale measure of such mutual influence is to observe how over the course of its modern development technology has been associated in the moral imagination with an overlapping series of images, from machines and industrial factories to computers and the internet, each of which has been an influence on and been subject to critical ethical reflection. Just as different images have tended selectively to engage and sometimes to reinforce different ethical judgments, ethical reflection has likewise tended to pick up and highlight differential images of technology.

Parsing the public images or synecdoches that the term "technology" often evokes — along with the cloud of associations that cannot help but be present as well in philosophical thought — it is possible to identify at least seven broad types. At the dawn of the popular recognition of modern technology as a distinctive phenomenon technology was easily identified with (1) machines and industrial factories, both of which also connoted power, as was even more specifically represented by the steam engine. The fact that human beings were the creators of such powerful machines could not help but promote a heroic vision of the human. Within a short period of time technology also became imagined in terms of (2) stores and homes well stocked with items denoting wealth and affluence; the Crystal Palace and the 1851 world fair exhibition of industrial products is perhaps an even more specific classical image that promoted a different notion of humans as consumers of mass produced goods and services. (3) Tall buildings and bridges have again suggested a heroic vision of the human associated with urbanization and technologically reconstructed spatio-temporal habitats, often contested as at once humanizing and dehumanizing. Electric lights, which are central to such reconstruction, are promiscuous metaphors in this regard, being associated at once with extending human action into the darkness and subjecting them to more exposure than they can always bear.

Re-emphasizing the notion of dynamism inherent in the image of industrial machines is another set of images associated with (4) transport by steam ships, railroad trains, automobiles, airplanes, and space exploration probes. Complementing transport are (5) communication technologies such as the telegraph, radio, telephone, and computer all of which are stationary or enclose yet dynamic electronic processes. Both would seem to endorse and be endorsed by dynamic moralities: in the one case an affirmation of physical change from place to place, in the other of rapid information acquisition and network connections, respectively.

Finally there are the conflicting images associated with leisure and with warfare. In the realm of (6) leisure technologies are motion pictures and film, television, and video games that signify the unification of technology and the production of human happiness. Yet although entertainment, the connotation of which cannot help but be predominately positive, is also subject to opposing ethical judgments in which such technologies serve to distract humans from more seriousness purpose and activity. To this same category might be added healthcare technologies as imaged by a host of medical instruments and devices from the stethoscope and cardiac monitor to the artificial heart. How could one not but be morally approving of the level of human health made possible by modern technology? But even this has been contested with arguments, however much they are themselves contested, concerning high costs (economic and psychological) if not hubris. By contrast, (7) military technologies are primarily imaged in terms of explosions, tanks, and bombs — with the predominant connection being one in which happiness is replaced by pain and suffering. Apologists for military technologies as providing defensive security have to struggle almost as much as critics of medical technologies in order to make their case.

These popular images have played out differentially weighted roles and distinctive issues in the three schools of ethical reflection on technology. For example, in the perspective of the socio-critical approach, machines and industrial factories are argued to be instruments of powerful elites from which they somehow need to be freed in order to realize their true liberating potential, whereas in a historico-cultural perspective an emphasis is placed on how such technologies constitute a historical transformation of unprecedented character. In the analytic perspective, by contrast, there is a tendency to see industrial machines as simply more complex tools, with different kinds of machines perhaps raising problems that call for philosophical reflection, without any need to pursue some kind of comprehensive assessment of technics and technology as a whole. Table 3 ventures a simplified summary of such a spectrum of different roles and issues. These images, simply as images, cannot avoid emphasizing the physical dimensions of technology. By contrast, some images call more attention than others to the dynamism of technological processes. Still others could be more easily interpreted to draw out the epistemic dimensions of technology and the ways it is linked with science, or the extent to which technology can occasionally be supported by and support some aspirations (such as desires for power and control) over others (such as contemplative awareness).

Additionally, such a conceptual map might also be used to revisit some of the different ways that ethics shapes technology and technology shapes ethics — again observing that some images tend to be more supportive of or resistant to one perspective than another. In a car culture it is relatively easy to make automobiles safer; in such a culture it is less easy to make places for bicycles and pedestrians. In a culture infused with technological making, using, and the engineering sciences there are also strong pressures to give ethical understanding and analysis forms that reflect or are compatible with such dominant phenomena.

Reflection on the interactive shaping of ethics and technology cannot help but raise questions about the degree to which ethics is truly able to shape or influence technology. To what extent is the ethical shaping merely marginal or decorative? To what degree can it be substantive? Or do such questions lack meaning, insofar as it becomes progressively difficult to conceive of humans separate from their

Table 3. Ethics and Technology Interactions: Images and Interpretations

Popular images of technology	Socio-critical reflection	Historico-cultural reflection	Analytic reflection
(1) Machines and industrial factories	Ruling class power, working class oppression	Industrial Revolution	Productive process, creativity
(2) Shopping marts, clothes, money	Distraction from liberating potential	Consumer culture undermines creativity	Issues of distributive justice
(3) Tall buildings and bridges	Alienating vs possibilities for humanizing architecture	Urbanization replaces community with society	Can exemplify creativity and technical beauty
(4) Steam boats, trains, cars, and airplanes	Must not be restricted to the wealthy classes	Travel uproots people, alienates from place	Need to promote safety through regulation
(5) Telegraph, radio, telephone, computers, internet	Critical of broadcast control but not distributed networks	Enhanced technical means without enhanced content	Raise issues of privacy and equal access
(6) Movies, TV, videos games — and medical technologies	Need for more democratic participation — and patient consent	Mass culture is a cultural decline — and an addiction to physical well being	New forms of art and entertainment are being created — post-humanist possibilities
(7) Explosions, tanks, and bombs	Caused by ruling class control and mistaken ideologies	Reveals inherent destructiveness	Dangerous risks to be moderated and restrained

technologies? Maybe the question of whether or not ethics influences technology is practically analogous to questions about whether there is an external world or other minds: If one begins with doubt about the reality of the external world or other minds, it is difficult to see how one can ever prove their existence. The external world and other minds are structured into and presumed by the very thought that would try to consider their absence.

Nevertheless, given the extent to which images can be used selectively to promote arguments for ethics shaping technology or technology shaping ethics — at multiple levels and in multifarious ways — it can only be concluded that the interaction of ethics and technology must also make alliance with other philosophical engagements and arguments. Although in philosophy of technology ethics may have received quantitative pride of place, philosophical pursuit of the ethics of technology cannot finally be sustained without considering such questions as how to define technology, the ontology of technological objects, the structures of technological action, and the epistemic dimensions of technology. In the end it is necessary to bring philosophy as a whole to bear to help make reasoned judgments about which images are more adequate than others — and to what extent some approaches (or parts thereof) to understanding ethics and technology interactions might be more adequate than others.

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