ENCYCLOPEDIA OF science technology AND ethics

EDITORS AND CONSULTANTS

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EDITED BY

CARL MITCHAM

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LASSWELL, HAROLD D.

Born in Donnellson, Illinois, Harold D. Lasswell (1902–1978) was an innovator in a number of scientific disciplines and the major figure in developing the policy sciences. The son of a teacher and a Presbyterian minister, he was educated at the University of Chicago, earning a doctorate in political science and then joining the faculty in 1926. In 1938 Lasswell moved to Washington, DC, to serve as a researcher and policy adviser. After the war, as a professor at Yale, Lasswell collaborated with the lawyer legal scholar Myres S. McDougal (1906–1998) and others on law, science, and policy. His broad interests and travels brought him into direct contact with many of the major intellectual and political figures of his time.

Lasswell wrote that "it is growth of insight, not simply of the capacity of the observer to predict the future operation of an automatic compulsion, or of a non-personal factor, that represents the major contribution of the scientific study of interpersonal relations to policy" (1951, p. 524). Insight brings those factors into conscious awareness, leaving the individual free to take them into account in making choices. Freedom through insight often modifies interpersonal relationships; hence, all propositions about those relationships are subject to new insight. Lasswell took the lead in developing the intellectual tools of the policy sciences to integrate and apply natural and social science insight to the fuller realization of human dignity for all, including freedom.

In his presidential address to the American Political Science Association, Lasswell chose "to inquire into the possible reconciliation of man's mastery over Nature [through science-based technologies] with freedom, the overriding goal of policy in our body politic" (1956, p. 961). At the outset he considered atomic weapons in order to entertain the proposition that "our intellectual tools have been sufficiently sharp to enable political scientists to make a largely correct appraisal of the consequences of unconventional weapons for world politics." After using those tools to sketch the kind of analysis that could have been done before the use of atomic weapons in 1945, he concluded that the profession had not institutionalized procedures to anticipate technical developments that had been reported publicly before the war and clarify in advance the main policy alternatives open to decision makers: "As political scientists we should have anticipated fully both the bomb and the significant problems of policy that came with it" (Lasswell 1956, p. 965).

Lasswell qualified this statement of professional responsibility, however: "I do not want to create the impression that all would have been well if we had been better political scientists, and that we must bear upon our puny shoulders the burden of culpability for the state of the world today. We are not so grandiose as to magnify our role or our responsibility beyond all proportion. Yet I cannot refrain from acknowledging . . . that we left the minds of our decision makers flagrantly unprepared to meet the crisis precipitated by the bomb" (1956, p. 965). Moreover, the profession was not responsible for information on the bomb withheld by officials. "We must however assume responsibility for any limitation of theory or procedure that prevented us from making full use of every opportunity open to us" (Lasswell 1956, p. 964).

Turning to the future, Lasswell asserted, "It is our responsibility to flagellate our minds toward creativity, toward bringing into the stream of emerging events conceptions of future strategy that, if adopted, will increase the probability that ideal aspirations will be more approximately realized" (1956, p. 966). Lasswell accepted that responsibility when he applied the intellectual tools of the policy sciences to potential applications of science in production of material goods and evolution of intelligent organisms (including humans) and machines as well as weapons. Particularly creative and prescient were certain remarks on the implications of genetics, embryology, and intelligent machines for evolution (Lasswell 1956, pp. 975–977):

- Because new species already had been created or re-created experimentally, "A garrison police regime fully cognizant of science and technology can, in all probability, eventually aspire to biologize the class and caste system by selective breeding and training."
- Because machines already had solved complex problems, "at what point do we accept the incorporation of relatively self-perpetuating and mutually influencing 'super-machines' or 'ex-robots' as being entitled to the policies expressed in the Universal Declaration [of Human Rights]?"
- Perhaps most disturbing was "the possibility that super-gifted men, or even new species possessing superior talent, will emerge as a result of research and development . . . introducing a biological elite capable of treating us [as] imperial powers have so often treated the weak."

Lasswell concluded by outlining a program of contextual and problem-oriented research using the tools of the policy sciences to address the aggregate effects of any specific innovation: "Our first professional contribution . . . is to project a comprehensive image of the future for the purpose of indicating how our overriding goal values are likely to be affected if current policies continue" (1956, pp. 977–978). The concluding task is "inventive and evaluative. It consists in originating policy alternatives by means of which goal values can be maximized. In estimating the likely occurrence of an event (or event category), it is essential to take into account the historical trends and the scientifically ascertained predispositions in the world arena or any pertinent part thereof."

Lasswell later noted discrepancies between the earlier promises of science-based technology and current reality: "If the promise was that knowledge would make men free, the contemporary reality seems to be that more men are manipulated without their consent for more purposes by more techniques by fewer men than at any time in history" (1970, p. 119). After a diagnosis of such discrepancies, he observed that their potential effects on science are not trivial, "for science has grown strong enough to acquire visibility, and therefore to become eligible as a scapegoat for whatever disenchantment there may be with the earlier promises of a science-based technology." The proposal again called for the perfecting of institutions to apply the intellectual tools of the policy sciences (Lasswell 1971, Lasswell and McDougal 1992) on a continuous basis toward policies to advance human dignity for all.

Relatively few scientists have answered the call despite the continuing relevance of Lasswell's proposal. This may be partly the result of a specialized vocabulary that critics claim is a barrier to the policy sciences. Nevertheless, if more scientists do not come forward, humankind's growing mastery of nature will jeopardize human dignity and the privileged position of science in society.

RONALD D. BRUNNER

SEE ALSO *Freedom; Governance of Science; Political Economy; Political Risk Assessment; Science Policy; Soft Systems Metholology.*

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LEIBNIZ, G. W.

Diplomat and court councilor to the house of Brunswick in Hanover, Gottfried Wilhelm Leibniz (1646–1716) was born in Leipzig on July 1. By the age of twenty-one he had earned a doctorate of law and written a *Dissertation on the Art of Combination,* which allowed him to lecture in philosophy. Though he never formally held an academic position (he had jobs as a jurist, librarian, mining engineer, and historian), his duties in Hanover enabled him to travel and meet many well-known thinkers of his time, such as mathematician Christian Huygens (1629–1695), who tutored Leibniz in mathematics during the latter's visit to Paris from 1672 through 1676. While he published several scholarly articles and only one book during his lifetime, the *Theodicy,* his large body of posthumously published work reveals Leibniz's contributions to mathematics, logic, science, law, philosophy, and ethics.

A rationalist, Leibniz exhibited a characteristically modern ambition with an ambitious scientific attempt to create a universal science of all human knowledge, which consisted of a universal, simple (i.e., numerical) language and a formalized calculus for reasoning. Though he eventually acknowledged the impossibility of completing the task because of the perspectivity of human knowing, he pursued this project until the end of his life. Leibniz's crowning achievement was his discovery of the infinitesimal calculus. Although Isaac Newton (1643–1727) discovered the infinitesimal calculus several years earlier, their achievements were independent and Leibniz's system of notation (published before Newton's) continues to be used in the early twenty-first century.

G. W. Leibniz, 1646–1716. Leibniz was a German mathematician and philosopher. Known as a statesman to the general public of his own times and as a mathematician to his scholarly contemporaries, he was subsequently thought of primarily as a philosopher. *(The Library of Congress.)*

To understand Leibniz, one must acknowledge the fundamental premise behind his thought: God created the best of all possible universes by achieving the maximum amount of diversity consonant with unity. This cannot be proven but must be accepted as true for rational inquiry to be possible. From this premise Leibniz identified five basic *a priori* metaphysical principles to guide inquiry: the principle of sufficient reason (for every event or thing there is a reason for its being what it is rather than otherwise) the principle of non-contradiction (that an essence cannot contain opposite properties in the same way at the same time) the principle of perfection (that God always creates by choosing the maximum amount of perfection) the principle of the identity of indiscernibles (that no two things can be identical in all respects save spatial location) finally, the principle of continuity (that there are no "gaps" in the perfection of the created order). In revised version, these premises may still be argued to underlie even empirical scientific research.

Leibniz's scientific method, "the conjectural method a priori," assumes certain hypotheses to demonstrate that natural occurrences follow from them. It is a priori because it relies on his five basic metaphysical principles. Leibniz used it to improve the mechanics of philosopher René Descartes (1596–1650) by distinguishing between speed and velocity, and to criticize Newton's description of force. Moreover, this method was not meant merely for demonstration, but also for technological invention (which motivated Leibniz: for example, he invented a calculator). Most of his technologies nevertheless failed, but many of his proposals foreshadowed later technological developments. For example, he attempted to use windmills to remove water from mines and proposed a system of ball bearings to improve the efficiency of carriage rides.

Leibniz rejected Descartes's metaphysical dualism of mind and matter, and its major scientific presupposition, namely that the physical universe is a *res extensa,* whose causality is exclusively mechanistic. One reason for rejecting matter as the basic element of the universe is its infinite divisibility. This leads to an infinite regress when trying to explain matter, thereby constituting a violation of the principle of sufficient reason. Instead, Leibniz argued for the monad as the most basic element of reality.

Monads are immaterial, "windowless" (that is, there is no causal interaction between monads), microcosms of the universe, the basic activity of which is perception. God harmonizes each monad (which contain all of their predicates analytically) according to his supremely perfect divine plan. Moreover, each person, as a unified collection of monads, has a unique perspective on the universe and, consequently, gets at some degree of truth. Hence, Leibniz insisted that rational inquiry must take place within an intersubjective community.

Leibniz's emphasis on intersubjectivity is reflected in his ethics, which focuses on three concepts: wisdom, virtue, and justice. Wisdom leads to happiness because all moral action must be guided by thought. Happiness is a durable state of pleasure (i.e., understood as perfection). Virtue is the habit of acting according to wisdom, and justice is the charity of the wise person, who pursues the good of others. These are assumed to be the motivations of all technology.

Leibniz's impact cannot be adequately measured. In addition to influencing such thinkers as Immanuel Kant, Edmund Husserl, and the quantum physicist David Bohm, Leibniz's aspirations continue to be a resource for those seeking to reconcile modern science, technology, and ethical responsibilities.

CHRISTOPHER ARROYO

SEE ALSO *Husserl, Edmund; Kant, Immanuel; Theodicy.*

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LEOPOLD, ALDO

Aldo Leopold (1887–1948), who was born in Burlington, Iowa, on January 11, was a pioneer of the American environmental movement. His essay "The Land Ethic," published in *A Sand County Almanac* (1966 [1949]), has become a foundational text of American environmental ethics. Leopold challenges his readers to reevaluate their relationship to the land they inhabit and act in accordance with a "land ethic" that "enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land" (Leopold 1966, p. 239). In his work the land and the biotic community become more than symbolic or abstract entities; they become beings with an intrinsic right to exist. Extending ethics and rights to the land, according to Leopold, necessarily "changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it" (Leopold 1966, p. 240). Leopold died in Baraboo, Wisconsin, on April 21.

Leopold's love of the land began when as a young naturalist he hunted and fished in his native Iowa. He took his interest in the natural world to Yale's School of Forestry in 1904. During his four years at the school founded by Gifford Pinchot (1865–1946), the first director of the U.S. Forest Service, Leopold absorbed the utilitarian philosophy of the early conservationists (Nash 1989). He served in the Forest Service from 1909 to 1928, working in Apache National Forest in Arizona and then managing the Carson National Forest in New Mexico. By 1928 his earlier studies in ecology and practice of game and forest management had taught him to see the world as a web of interrelated systems. He also came to understand the lasting consequences of individual action on the landscape. In "The Land Ethic" Leopold uses the term *biotic pyramid* to describe the dynamic relationships that exist among organisms and their environments. "Land," he argues, "is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals" (Leopold 1966, p. 253). In 1933 Leopold accepted an appointment in wildlife management at the University of Wisconsin.

The year 1935 was an important one for Leopold: His concern for vanishing American primitive areas led him to cofound the preservationist group the Wilderness Society. Leopold also purchased an abandoned, 120-acre farm in Sauk County, Wisconsin. It was in that setting that Leopold tried to articulate what it means to have an ethical relationship to the land. *A Sand County Almanac*, the record Leopold created of his years on the farm and his maturing environmental philosophy, was published in 1949, a year after he died fighting a fire on a neighbor's farm.

In his short piece "Axe in Hand" from *Almanac* Leopold provides an illuminating vignette on bias, showing how he imagines his relationship to the plants and animals that coinhabit his space and how he executes, sometimes literally, his decisions involving land management. The context for Leopold's dilemma is the felling of a tree; the decision he must make is between the white pine and the red birch, two species that crowd each other in those woods. Leopold examines the biases that influence a conservationist, which he defines as the axe wielder "who is humbly aware that with each stroke he is writing his signature on the face of the land." He is specifically intent on examining the "logic, if any" behind his own biases (Leopold 1966, p. 73). Leopold understands that his biases are a filter through which he passes the details of the landscape, making his world and the objects in it comprehensible.

The examination of individual biases—in this case Leopold's inquiry into his preference for the pine over the birch—forms the first stage in the development of an ethical relationship to the land. What Leopold describes is land as a system with an integrity of its own. The boll weevil, for instance, will or will not attack the pine if certain relations with the birch exist or do not exist. Some plants will thrive and others will not, depending on whether the birch or the pine is there to give them shelter. When the axe wielder enters the scene, he has the potential to disrupt that system. His examination of bias enables Leopold to see all the possible consequences of his actions and act in a thoughtful manner.

In this essay Leopold paints a portrait of a community in which he is as much a part of the environment as are the trees, insects, and birds; he, like them, has a role to play. In "Axe in Hand" Leopold demonstrates what he calls in "The Land Ethic" the "ecological conscience"; that conscience, he writes, "reflects a conviction of individual responsibility for the health of the land" (Leopold 1966, p. 258). Leopold summarized the principle behind the land ethic as follows: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1966, p. 262). Leopold's land ethic forces a reevaluation of the "value" of land broadly conceived and requires that limits be placed on the individual in favor of the health of the biotic community.

TINA GIANQUITTO

SEE ALSO *Environmental Ethics; Multiple Use; Wildlife Management.*

Aldo Leopold, 1886–1948. Leopold was an early environmentalist who laid the groundwork for many of the conservation laws and policies in place today. *(AP/Wide World Photos.)*

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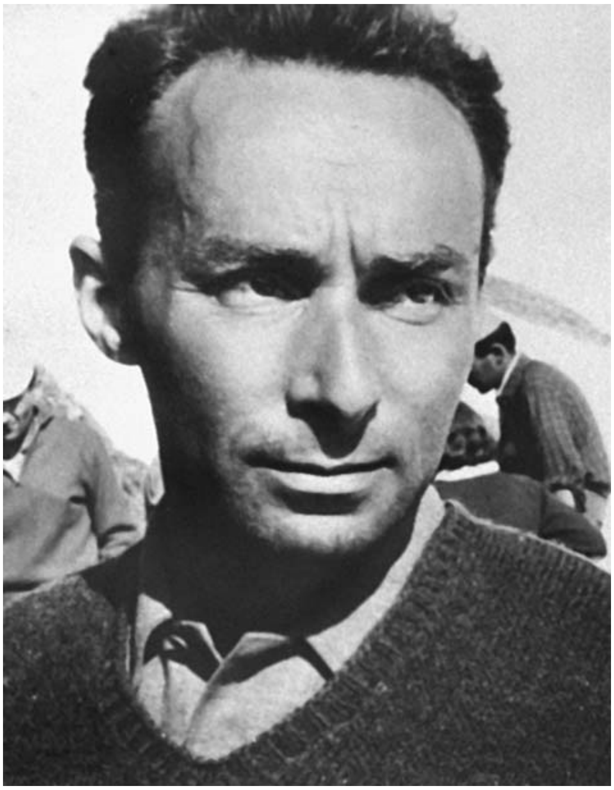
LEVI, PRIMO

Primo Levi (1919–1987) was born to an assimilated Jewish family in Turin, Italy. In 1944, after training as a chemist, Levi joined a group of antifascist partisans, was captured, and was deported to the concentration camp at Auschwitz. He survived and returned to Turin in



Primo Levi, 1919–1987. An Italian author and chemist, Levi was considered one of the foremost writers of concentration camp literature. *(The Library of Congress.)*

1945, at which point he embarked on joint careers as an industrial chemist and an author, publishing the account of his experiences titled *Se questo e un uomo* (If this is a man) in 1947. The book, published in the United States as *Survival in Auschwitz,* is considered to be among the finest accounts of the death camps.

Levi retired from his work as a chemist in 1978 and fell to his death in his Turin apartment building on April 11, 1987. Debate continues about whether Levi, who experienced repeated bouts of depression, killed himself or fell by accident.

Throughout his work Levi stressed the connections between science, literature, and ethics. His use of chemistry as an inspiration for storytelling in *The Periodic Table* (1984) made scientists more attuned to literature and readers of literature more appreciative of science.

One theme unifying Levi's diverse essays and short stories is his belief in the importance and value of work. Levi believed that human beings are naturally constituted to need to work, to strive toward a goal and solve problems encountered in doing so. He emphasized the importance of practice and effort and saw science as a particularly important forum for the struggle to survive and grow.

Levi argued that technology does not necessarily alienate humanity from nature but can enhance the rapport between them. At the same time he emphasized the capacity of humanity for self-transformation, which necessarily means defying and altering nature. He believed that through its inventions humankind has turned its back on nature, damaging both people and the natural world but also improving the lot, and raising the stature, of individuals. Levi argued that one must learn from nature but that one also learns from struggling against it.

Levi eschewed both triumphalism and despair regarding humanity's prospects and the contributions to them made by science. He emphasized that progress will always be noisy, dangerous, and limited. However, because people are adaptable and capable of courage, reason, and strength, progress is possible. Levi celebrated the "cheerful strength" and "sober joy" connected with thought and invention, which allow human beings to endure and learn. He spoke of himself as a man sustained by curiosity about the world and emphasized the value of the inquiry that human curiosity fuels. However, he also acknowledged that the struggle to unlock the secrets of nature through measurement and categorization can be monstrous as well as heroic.

Levi, who was particularly worried by the proliferation of nuclear weapons, called on his fellow scientists and technicians to "return to conscience," to become aware of their immense and potentially sinister power. He insisted that science is not neutral; it either helps or harms human beings. Scientists should not stop doing research for fear of the possible negative consequences of their work, but they should concern themselves with the results of their work and avoid research that leads to immoral results. Scientists should resist the temptation of material rewards and intellectual stimulation, engage in work that will benefit and not harm their fellow human beings, and speak out against the misuse of science by others.

Levi's short stories often satirize the arrogance, ambition, and desire for control or enrichment that can lead scientists to ignore or abandon moral scruples in pursuing and applying knowledge. He warned against submissiveness to power and urged that "a precise moral consciousness" be instilled in scientists as part of their training; he also recommended that scientists take a sort of Hippocratic oath to do no harm (Levi 2001, pp. 71, 89–90).

Levi's reflections on the ethical dimension of science emphasize potential benefits as well as limitations, hope as well as danger, and the joys of discovery as well as moral responsibility. He believed that human beings are alone in a universe not made for their well-being and warned that although science gradually reveals the secrets of the cosmos, those secrets do not provide answers to "big questions" regarding the aims of human life; those answers can come only from within human beings. People's reason for being, he concluded, rests on their nature as, in the words Levi quoted from Pascal, "thinking reeds" who seek knowledge and excellence, and this quest is the source of human dignity.

JOSHUA L. CHERNISS

SEE ALSO *Holocaust; Science, Technology, and Literature; Work; Scientific Ethics.*

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LEVINAS, EMMANUEL

Emmanuel Levinas (1906–1996), who was born in Lithuania of Jewish parents, studied the Hebrew Bible along with the works of the Russian authors Aleksandr Pushkin (1799–1837), Fyodor Dostoyevsky (1821–1881), and Lev Tolstoy (1828–1910). In 1928 and 1929

Emmanuel Levinas, 1906–1995. Levinas was a major philosopher of the 20th century who attempted to proceed philosophically beyond phenomenology and ontology and to engage in a more immediate and irreducible consideration of the nature and meaning of other persons. (© *Bassouls Sophie/Corbis Sygma.*)

he attended the philosopher Edmund Husserl's (1859–1938) lectures in Freiburg, Germany, and started writing a dissertation on Husserl's theory of intuition. He also attended lectures given by the philosopher Martin Heidegger (1889–1976). Levinas was largely responsible for introducing Husserl and Heidegger to French philosophers, most notably Jean-Paul Sartre (1905–1980).

Levinas's first major work, *Totality and Infinity*, was published in 1961. It was only in the 1980s that a wider audience acknowledged Levinas's work, and his thought eventually became central to postmodern ethics. A number of authors, including philosophers and theorists such as Jacques Derrida (b. 1930), Zygmunt Bauman (b. 1925), John D. Caputo (b. 1940), Robert Bernasconi (b. 1950), and Simon Critchley (b. 1960) adopted his ideas, so that any discussion of ethics outside the analytical tradition would be incomplete without reference to Levinas. This is also true with regard to ethics in science and technology.

Ethics: Not Theory but Happening

For Levinas ethics is not a theory, a rule, an idea, or knowledge of how people ought to act or live. In this sense it can be said that his work falls outside the traditional field of ethical theory. For Levinas ethics is a profound and disruptive event in which the Other disrupts and shatters the self-certain I. Levinas uses the term *Other* (with a capital letter) to refer to the absolute singularity of each human being. Ethics is a disruptive event in which a person's claims to rights and deserts is questioned radically in the face of the infinitely singular person before that individual here and now—the "widow and the orphan." If such persons call on an individual for help or support, that act recalls the individual's guilt, pointing out that that individual has from his or her very beginning taken the place in the sun of the person who has asked for assistance. Levinas would argue that an individual's particular existence has its origin in and through a terrible and violent act seizing the place of the Other who is calling on that individual. This primitive primacy of the individual's guilt, the birth of the ethical question, is Levinas's most profound insight, elaborated in all his works.

Why is the individual already guilty? In taking up his or her personal existential project (to be that particular person), the individual has taken the "place in the sun" of the Other. Further, in making sense of the world and those who cross his or her path, the individual continues to *reduce* the Other to the themes and categories (mother, criminal, politician, manager, man, black, etc) of his or her comprehension. Others become "domesticated" as themes or categories "for-me" through and by the individual's ongoing comprehension of them. This domestication prolongs and extends the violence that began at the birth of a person's individual existential project. Thus, that person has been guilty from the start. For Levinas ethics becomes possible when a person acknowledges that the Other—the particular singular person facing the individual—is infinitely more than any idea (theme, category, attribute) that the individual can use in his or her ongoing comprehension. How, then, can a relationship with the Other be anything but comprehension, how can one encounter the other as Other? Working this out is Levinas's task.

Levinas claims that ethics happens in the "saying" or speaking of language. When the particular Other faces a person and speaks or makes a nonlinguistic gesture, there is more in the words than the message: There is a residue, a trace, of the Other that disturbs the hearer. Levinas uses the familiar event of a doorbell ringing and disturbing one's work and thoughts, but when one opens the door, there is nobody there. Was there nobody there? Did the hearer imagine it? The hearer cannot recall anything but the disturbance. Just when the hearer settles back into his or her thoughts, the doorbell rings again, but there is never somebody there. In the recalling of ethics people are affected without the source of the affection becoming something they can think about as such. It is this relationship of incessantly there but never present that Levinas calls proximity: the disturbing face before the individual that is (re)calling that individual's responsibility. The only recourse in this moment of ethics is to respond, to take up the responsibility for one's original and ongoing violence. For Levinas one is a particular person because one has these particular responsibilities. This is the only possibility for ethics. As he expresses it: "In her face the Other appears to me not as an obstacle, nor as a menace I evaluate, but as what measures me. For me to feel myself unjust I must measure myself against infinity" (Levinas 1996b, p. 58).

Is the individual not also a face? Who will look out for that person? These questions lead to the issue of justice. The radical asymmetrical ethics of Levinas must be reinserted into the symmetrical relationship of justice in which all people are equal before the law. Thus, Levinas claims that it is necessary to add "the third" (all other people) to the relationship of the self and the Other. This is the moment of justice. It involves the need to compare what is never comparable, the dilemma a judge faces in the courtroom every day: to treat all people as equal even though they are absolutely different ("singulars" in Levinas's terminology). Nevertheless, for Levinas the urgency of justice stems from the radical asymmetry of the original ethical relationship. Without such a radical asymmetry—the ethical relationship—the claim of the Other always can be subject to codes, rules, and regulations. Then justice becomes mere calculation and (re)distribution. Thus, justice has its standard, its force, in the proximity of the face of the Other: "The equality of all is born by my inequality, the surplus of my duties over my rights. The forgetting of self moves justice" (Levinas 1991 (1974), p. 159).

Implications for Science, Technology, and Ethics

Levinas's ethics is important in thinking about ethics more generally. One could say that it is a call to rescue ethics from theory. Nevertheless, Levinas's work is particularly important to science and technology. In the epistemological categories of science and the mechanisms and algorithms of technology the absolute singular (the individual particular person) does not fit well. One could see how the singular person becomes a subject, subjected to the logic of the method. In the mechanisms and algorithms of technology the individual person can become an exception (perhaps an error) to be discarded in favor of the categories those technologies rely on for their smooth operation.

Given this seemingly obvious conclusion one could draw from Levinas' ethics above, it is surprising to find that Levinas (1990) takes a very positive view of science and technology. In discussing the space program he argues that science and technology strips nature of its divine pretentions, thereby allowing humans to harness it in the service of humanity. Nevertheless, such a view that posits science and technology as neutral 'tools' that can and ought to be applied in the service of humanity denies the value ladenness of science and technology as well as the political structures within which these human endeavours function. Thus, as Peperzak (1997) argues: "the inherent violence of technology cannot be overcome by technological practice. The micro-ethical practice of persons who are well disposed to others, nature, and art, notwithstanding the distorting networks in which these people function, can point the way towards a better disposed constellations of justice, technological utility, and natural beauty" (p. 143).

Thus, ethically minded designers of technology must ask which categories they assume when they are designing. What about those who do not fit? Moreover, as people apply science and technology in the ordering of society, many singular faces may suffer as they fall through the cracks of method and machine. Does that mean that science and technology are inherently violent? Levinas (1990) would argue that this is necessary violence in the service of freedom and justice. Nevertheless, in its service of justice the ultimate measure should be the proximity of the face of the Other; without this standard it would pursue its path as pure violence.

One could say that Levinas's ethics leaves humankind with plenty and with nothing. The call of the Other is powerful, but how can it be worked out in every instance? Ethical theories such as utilitarianism and consequentialism provide resources to decide what one ought to do in a particular case. However, according to Levinas, all people are guilty and must respond, yet when they respond, they may perpetuate violence. Derrida (1992) claims that Levinasian ethics is impossible because it provides no clear answer or procedure for deciding what to do. This, paradoxically, is an answer. It is the impossibility of ethics that provides the urgency of ethics and interrogates every decision. If making ethical decisions were possible through the use of a rule or procedure, people might forget the plight of the particular individual, the Other. Impossibility is what keeps people open to the possibility of encountering the other as Other in every situation. For Derrida and Levinas it is impossibility that makes ethics possible.

Is Levinas's ethical system anthropocentric? Can other animals and other things have a face? Are they also absolute singulars? Does Levinas deny a responsibility toward nonhuman others? A number of authors have argued against Levinas's ethics on these grounds. Feminist authors have stated that his work is based on the predominant view of the male ego of autonomy and competition as opposed to the female ego of affiliation, empathy, and nurturing (Chanter 1988). Deep ecologists have argued against his exclusion of nature from the realm of morality (Gottlieb 1994). Levinas scholars such as John Llewelyn (1991) and Adriaan Peperzak (1997) have responded to these criticisms. In contrast to these critical comments, Benso (2000), with the help of Heidegger, uses Levinas to make a powerful argument for an "ethics of things." Such an approach points toward the application of Levinas's thought to science, technology, and ethics.

LUCAS D. INTRONA

SEE ALSO *French Perspectives; Heidegger, Martin; Phenomenology.*

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LEWIS, C. S.

Novelist, critic, poet, essayist, and Christian apologist Clive Staples Lewis (1898–1963) was born in Belfast on November 29, served in France, and was wounded during World War I. He completed his undergraduate studies at University College, Oxford, in 1922, and from 1925 until 1954 was a Fellow of Magdalen College, Oxford, and tutor in English. From 1954 until just before his death he was Professor of Medieval and Renaissance Literature at Cambridge.

Lewis once wrote that although he was a rationalist who had *scientific impulses*, he could have never been a scientist. He considered the role and direction of science for nearly three decades and mentioned and alluded to it in many of his works. He was aware of its limitations and methodology, and was respectful of its status as a type of knowledge that could be used for the benefit of humanity. Lewis praised genuine scientific accomplishment and said that scientific reason, if accurate, was valid, although it was not the only kind of reasoning. Truth, value, meaning, and other ideals were necessary presuppositions to the scientific method but were not themselves scientific phenomena.

Lewis was sometimes accused of being unscientific and discrediting, or even attacking, scientific thinking. In reality he criticized what he called *scientism*, a reductionist outlook on the world that popularized the sciences. Scientism (*science deified*) occurred when a naturalistic worldview was linked to the empirical method of experimentation. Scientism as radical empiricism rejected the truth of a nonquantifiable reality such as God.

C. S. Lewis, 1898–1963. An author and scholar, Lewis is known for his work on medieval literature and for his Christian apologetics and fiction, especially *The Chronicles of Narnia*. *(AP/Wide World Photos.)*

Lewis saw the Genesis creation accounts as non-literal folk tales or myths. In *The Problem of Pain* (1940), he presented a modified view of creation and the Fall because scientific evidence that "carnivorousness was older than humanity" had led him to believe that evil had manifested itself long before Adam (Lewis 1940, p. 121). He had a theistic view of evolution but resisted attempts to draw broad philosophical implications from various scientific theories of it. He was never directly opposed to science, but believed many scientific theories were tentative and dependent on changing presuppositions and *climates of opinion*. Early evidence from his letters indicate that he denied that biological evolution was incompatible with Christianity; in later letters he became increasingly pessimistic about evolutionism as a progressive philosophy. Earlier he felt that the theory of evolution was often held because of dogmatic, not scientific reasons, but he never gave up his long-held view that biological evolution was compatible with Christian accounts of creation. He opposed evolutionism as a philosophical theory, not evolution as a biological theory.

In many of his writings Lewis tried to redefine the role of science and its proper role in society. He believed that scientism was in error in that it reduced life to abstractions and denied the possibility that physical events and human experiences had God behind them. He observed that since scientism was only concerned with how things behave, it was not qualified or capable of *looking behind things*, particularly the power behind the universe.

In his much-praised defense of natural law, *The Abolition of Man* (1943), Lewis discussed the possibility of a world that no longer believed in objective truth and value. He saw this as possibly leading to a power struggle in which societal elites tried to control and recondition society. "Man's conquest of Nature, if the dreams of some scientific planners are realized, means the rule of a few hundreds of men over billions and billions of men . . . Each new power won *by* man is a power *over* man as well" (Lewis 1955, p. 70).

Many of Lewis's ideas in *The Abolition of Man* were expressed dramatically in his space novel *That Hideous Strength* (1945). In the story, the degeneration of humanity nearly occurs as a result of a gross scientific materialism controlled by bureaucrats that is devoid of all idealistic, ethical, and religious values. Lewis satirized materialistic scientists in *That Hideous Strength* by showing them as ignoring metaphysical reason and refusing to submit their claims to any kind of moral or religious authority.

He wrote his trilogy of space novels (the others being *Out of the Silent Planet* [1938], and *Perelandra* [1943]) as a result of reading Olaf Stapledon's (1886–1950) *Last and First Men* (1930) and the Cambridge biochemist J. B. S. Haldane's (1892–1964) essay "Man's Destiny" (1927), both of which took interplanetary travel seriously but contained an immoral outlook that denied God. He was openly critical of Stapledon's fictional universes, in which science represented the greatest good and Christian ideals played no essential role. After reading Stapledon's *Star Maker* (1937), Lewis said that the race Stapledon described was concerned primarily for the increase of its own power by technology, a technology that was indifferent to ethics, and a *cancer in the universe*.

PERRY C. BRAMLETT

SEE ALSO *Anglo-Catholic Cultural Criticism; Christian Perspectives.*

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LIBERALISM

Liberalism as a theory about politics and society upholds freedoms of belief, inquiry, expression, action, association and elections. In liberalism, freedom coalesces with value-commitments to equality, individualism, toleration, pluralism, and rationality. All of these commitments have interacted with science and technology in multiple ways.

Classical Liberalism

Liberals differ over determining the nature of freedom. Isaiah Berlin's distinction between negative and positive freedoms (freedom *from* as against freedom *to*) is useful in explaining the difference between classical and modern forms of liberalism.

In classical liberalism, freedom is interpreted in terms of a *private* sphere of non-interference that is supported by the rule of law. Free agents are protected from arbitrary interference, being left to enjoy their possessions, to retain personal beliefs, and to act in preferred ways on the condition that they respect the freedom of others to do the same. Support for private property and free markets goes hand in hand, in classical liberalism, with a prescription that power (economic as well as political) be divided so as to alleviate the risk of its being abused.

John Locke (1632–1704), whose *Second Treatise of Civil Government* (1690) started the tradition of liberal thought, encapsulated classical liberalism in stating that "Liberty is to be free from restraint and violence from others which cannot be, where there is no Law" (1960, p. 324). Locke's form of liberalism supported parliamentary government and the rule of law in England against absolute monarchy.

Among French thinkers, Charles de Secondat, Baron de Montesquieu, in *The Spirit of the Laws* (1748), praised the English constitution for its separation of the powers of government and reflected adversely on the absolutism of the French monarchy. Tolerance, aversion to fanaticism, and advocacy of freedom of discussion and of the press characterize the writings of the eighteenth-century *philosophes,* including Marquis de Condorcet and Francois-Marie Voltaire. After the turmoil of the French Revolution and of Napoleon Bonaparte's rule, Benjamin Constant (1767–1830) and Francois Guizot (1787–1874) conceived of a liberalism that was conservative and admiring of English political institutions, while Alexis de Tocqueville (1805–1859) warned that democracy gives no guarantee of freedom and might end in tyranny.

Pre-eminent among German liberals, Immanuel Kant (1724–1804) conceived of liberty as the will determining itself according to its rational law, converting pure reason into practical reason. Kant's state is a legal organization, *limited* in its role of ordering legal rights, reconciling the free will of each individual with that of all others. The sphere of morality, for Kant, consists in individual conscience as the judge of the righteousness of acts. In 1927 Guido de Ruggiero contended that Kant's liberalism served to constrain the exercise of power in Germany through the nineteenth century because, "even in periods of the strictest absolutism," governments were checked "by a profound consciousness of" being restricted to the sphere of rights (de Ruggiero 1927, p. 220). In his *Essay on the Limits of the Action of the State* (1851), Wilhelm von Humboldt argued that the worthy faculties and qualities of individuals only develop in an environment that a minimalist state protects as free and pluralist. In Germany, as in France, liberals were nowhere near as committed to the market economy as were their English counterparts.

Among the sources of nascent U.S. liberalism was Locke with his ideas of natural rights, government by consent, and the entitlement of subjects to revolt against a government that betrays their trust. French *philosophes* could envision human perfectibility, but the liberals who contributed to the formation of the U.S. republic were skeptical. Their understanding of human nature derived from the Scottish Enlightenment: Adam Ferguson, David Hume and, particularly, Adam Smith who, in *The Wealth of Nations* (1776), argued for capitalist economics (the price mechanism as a beneficent *invisible hand*), the rule of law in a constitutional order, and equal freedom. Smith believed that a strong presumption exists against governmental activity, but his advocacy of laissez faire was not doctrinaire. A rule of thumb with Smith was that government should arrange social conditions in ways that would assist the market to provide public services; Jeremy Bentham and his circle embraced this theory. Adopting the principle of utility as his axiom, policies being calculated to advance the greatest happiness of the greatest number in society, Bentham inferred that joint stock companies should bid for government contracts to operate public institutions (prisons and poor houses).

Modern Liberalism

The emphasis in *modern* liberalism is placed on freedom as empowerment (freedom *to*). There has been no closer approximation to the ideal type of classical liberal society than nineteenth-century England in the era of William Gladstone and Richard Cobden. Nevertheless, after the reform of Parliament in 1832, governments in England—partly from the impetus received from Benthamite utilitarianism—became more active: reforming the administration of the poor law and of public health; regulating working hours, the police, and inspection of factories; and overhauling the civil service and local government.

Liberal thought in England also underwent a major revision with Lionel Hobhouse in 1911 describing the *liberal socialism* of John Stuart Mill (1806–1873) as the link *between the old and the new liberalism.* The *new liberalism* of the Hegelians Thomas Hill Green (1836–1882) and Bernard Bosanquet (1848–1923), appreciated the value of freedom as a positive power and recommended a more constructive mode of government. Agreeing with Mill that the core of liberalism consists in the "liberation of ... [the] spiritual energy" of agents (Hobhouse 1911, p. 137), Hobhouse proposed that the state should act so as to secure the economic conditions that would enable individuals to develop their faculties and to fully participate in the life of the community.

Two world wars and the intervening Great Depression led governments to assume a greater role in European and North American societies. John Maynard Keynes's *General Theory of Employment* (1936) explained how governments should use their fiscal powers of taxing and spending to regulate economic activity and control money supply as a means of mitigating the business cycle and unemployment.

In 1935, in the United States, John Dewey (1859–1952) expressed hostility to the free market order and its disparities in wealth. The Humboldt-Mill ideal of individual development as grounded in freedom that had impressed Green and Hobhouse was assimilated by Dewey and by many other liberal philosophers through the twentieth century. Dewey saw the ends of liberalism—"liberty and the opportunity of individuals" to fully realize "their potentialities"—as requiring governmental planning of "industry and finance" (1963, p. 51, 55).

The ideal of individual development is discernible in the most important work of liberalism to appear in the second half of the twentieth century, John Rawls's *A Theory of Justice* (1971). Arguing for redistribution and the welfare state, Rawls relied on principles of liberal justice. One of Rawls's tenets attributes freedoms of conscience, conduct, and religion to citizens; his other basic belief dictates that a redistribution of resources may only take place on the condition that the least well-off members of society will benefit from it. As a corollary, inequalities determined by an agent's social circumstances, and by that person's talents and abilities, are deemed to be illegitimate.

Prominent among the responses to Rawls's Kantian liberalism is *communitarianism*. Michael Sandel in *Liberalism and the Limits of Justice* (1982) demurred to Rawls's use of an abstracted individual to reason about justice, envisaging the self as being socially formed, and the individual as exercising reason only within the community.

The term *modern* liberalism does not mean that classical liberalism is an anachronism. The writings of neoliberals—Ludwig von Mises, Friedrich Hayek, Ayn Rand, and Milton Friedman—that influenced the governments of Margaret Thatcher and Ronald Reagan, confirm the durability of the classical liberal position. Neoliberals argued that the meliorist activity of democratic governments must be kept to a minimum if liberal societies are to avoid what Hayek sign-posted as *the road to serfdom*.

The distinction between classical and modern liberalisms is not a sharp one, the positions shading off into each other. Walter Lippmann (1889–1974), for example, was convinced that many services in modern society can only be provided by large governmental enterprises and he defended a redistribution of wealth as socially stabilizing. Lippmann held with the ideals of Smith, however, which turned him against Franklin Roosevelt's New Deal and other forms of *collectivism*. The political thought of Karl Popper (1902–1994) can be located with Lippmann's near the middle of the continuum between classical and modern liberalisms.

Science and Technology as Supporting the Achievement of Liberal Ideals

Liberalism and science have commonly been seen as buttressing each other. While recognizing that scientific research needed governmental funding, liberals argued that because scientists are experts in research they should be free to select their topics of, and methods for, research. In the 1940s, Michael Polanyi defended the autonomy of science against Soviet-style planned research, and Popper supported free inquiry by showing that knowledge advances in an unpredictable manner. Like Polanyi and Popper, Robert Merton depicted science as an exemplary liberal community, highlighting norms of universalism, communalism, disinterestedness, and organized skepticism.

Since the detonation of the atomic bomb, with the proliferation of weapons of mass slaughter and with the deterioration of the environment, even liberals have become ambivalent toward science and technology, although most remain sure that science and technology are conducive to liberal values. Without science and technology, liberals argue, freedoms of modern society—of the press and of the airwaves, for example—would be attenuated. Freedoms of election and association benefit from electronic communications and rapid transport. The technology of publishing serves the marketplace of ideas, and media technology helps in checking the power of government. Travel and the mass media expose more people to foreign cultures, encouraging tolerance of ethnic and cultural diversity. Dissemination of information by way of the Internet assists people in making free choices on matters of health, religion, education, and politics. In contributing to the material conditions of life that underlie the enjoyment of all liberties, science and technology have helped people, particularly in Europe and North America, to live longer, suffer less pain, and enjoy better health and greater comfort.

Science and Technology as Impeding the Attainment of Liberal Ideals

Much of the liberal image of science is out of date. In the early twenty-first century most scientists are a part of *big science*. Typically research is conducted by large teams, is capital-intensive, and is shrouded in secrecy because most scientists aim at producing innovations for industrial and governmental sponsors. While liberals are correct in claiming that science ails when governments and corporations instruct scientists on how to conduct their research, the fact remains that governmental controls on scientific research have become more stringent.

Science and technology may support the liberal values of freedom and tolerance, but in a number of ways they also *standardize* culture and social practices, as James Scott has argued. Paul Feyerabend (1924–1994) examined the idolization of science and technology—scientism and the cult of the expert—that so often takes responsibility away from laypeople and leads to the denigration of non-scientific beliefs and practices. In the first half of the nineteenth century, liberals (Tocqueville, Humboldt, and Mill) worried that newspapers and railways were creating a social *mass* that was hostile to individuality, diversity, and freedom. Concern about technology and the masses was also voiced by Max Weber (1864–1920) and José Ortega y Gasset (1883–1955). In the twentieth century, assembly line mass production and deskilling of the workforce in accordance with the precepts of Frederick Winslow Taylor's *scientific management* gave further impetus to standardization.

Social elites of scientists and technologists have privileged access to government policy makers and to funding agencies. They promote and benefit from scientism and standardization, having a major say over the curriculum and attracting the lion's share of resources for research in their fields.

In the hands of governments and corporations, modern science and technology have intruded deeply into the *private realm*. Although totalitarianism provided the most graphic evidence of mental regimentation by the electronic mass media, the mass media in democracies have been accused of *manufacturing consent*, indoctrinating consumers, and promoting irrationality. Computers and other information handling systems, security cameras, wire taps, and interception of on-line communications represent technologies that subject a citizenry to electronic *surveillance*.

STRUAN JACOBS

SEE ALSO *Civil Society; Communitarianism; Conservatism; Democracy; Lock, John; Merton, Robert; Mill, John Stuart; Neoliberalism; Polanyi, Michael; Popper, Karl; Rawls, John.*

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LIBERTARIANISM

Libertarianism is the belief that one has the right to dominion over one's own person, including the fruits of one's labor. Adults are entitled to make their own decisions and agreements. Coercion, particularly by the government, is wrong.

In contemporary American politics libertarians side with the far left in favoring personal freedom and side with the far right in favoring economic freedom. Thus, libertarians argue for the decriminalization of recreational drug use on the grounds that adults should have the right to make choices about their bodies. Libertarians oppose a national health care system as coercive and inevitably interfering with the rights of individuals to make their own choices about health care.

Libertarians view other ideologies as overly paternalistic. Politicians routinely begin a sentence with "We must," as in " We must reduce our dependence on foreign oil" or "We must spend more on education." A libertarian asks, "Who is this 'we'?" Libertarians argue that individuals can decide for themselves how much to spend on their own education. Moreover, people who want to see others obtain more education are free to donate funds for that cause. To libertarians "We must spend more on education" translates into "The government is going to coerce individuals into paying for their own or others' education."

For many people economic freedom is justified on utilitarian grounds. Those individuals endorse free markets because markets deliver economic growth and a high average standard of living. For libertarians economic freedom is justified on first principles. Even when government regulation is intended to make people better off, libertarians oppose such regulation as coercive. Thus, libertarians would not endorse most regulation carried out in the name of protecting consumers, preferring instead that consumers be expected to protect themselves.

Libertarianism faces a number of challenges. First, libertarians must establish the boundaries between freedom and coercion. In theory, one person's freedom can negate another's. The libertarian solution to this problem is to focus on property rights. If a person's property is clearly defined, no one may take that property without that person's consent. The libertarian's ideal role for government is to enforce property rights and nothing else.

Second, libertarianism is criticized for taking social institutions and cultural norms for granted. That is, libertarians speak as if society could function with only markets as institutions. However, markets operate in a context of cultural values and government protections, and chaos would result if those protections were taken away.

On the left critics of libertarianism argue that without social welfare programs the poor might turn to crime or armed insurrection. Without public education people might not acquire the basic tools needed to function in and maintain their society. On the right critics of libertarianism argue that individual morality is too fragile to prevail in the noncoercive environment favored by libertarians. Without the restraints imposed by religion, social opprobrium, and legal sanction people's behavior would degenerate, ultimately reaching the point where they no longer were capable of respecting themselves or one another.

Third, libertarianism is criticized as an ideology that ignores inequality and scorns the disadvantaged. This line of criticism is embedded in lines such as "The rich man and the poor man have equal freedom to sleep in the gutter" and "Freedom of the press exists only if you own one" (the second quote is attributed to the journalist A. J. Liebling).

These critics argue that property rights are not sufficient to make everyone free. They suggest that those born without sufficient endowments of land, capital, and aptitude are at the mercy of the powerful even in the absence of coercion. In response libertarians argue that government programs enacted for the benefit of the disadvantaged often are counterproductive, circumscribing freedom without aiding the intended beneficiaries.

History of Libertarianism

Libertarianism has its roots in Enlightenment philosophy, particularly the writings of the philosopher John Locke (1632–1704). Locke argued that dominion over one's own body and one's own property is a natural right. Locke viewed government as legitimate only if it has the consent of the governed. In Chapter 8 of the *Second Treatise on Government* Locke wrote, "The only way whereby any one divests himself of his natural liberty, and puts on the bonds of civil society, is by agreeing with other men to join and unite into a community for their comfortable, safe, and peaceable living one amongst another, in a secure enjoyment of their properties, and a greater security against any, that are not of it." Locke was a major influence on the founders of the United States, who embodied the contractual theory of government in the U.S. Constitution. The U.S. Bill of Rights also reinforced libertarian ideas of natural rights.

Another major libertarian work is *On Liberty* by the philosopher John Stuart Mill (1806–1873). Mill argued that social condemnation could be as oppressive as government coercion.

In the twentieth century one of the most important libertarian thinkers was Friedrich Hayek (1899–1992), who argued against the dominant view that a modern economy requires central planning and a welfare state. Hayek believed that the price system, fed by local information in markets, is more efficient than any central planner. For him the coercion required to implement the welfare state would undermine freedom and thus was *The Road to Serfdom* (1944).

The Internet and Libertarianism

In 1996, John Perry Barlow, a writer and activist in the Electronic Freedom Foundation (EFF), composed "A Declaration of the Independence of Cyberspace," which argued that government should adopt a hands-off approach with respect to the Internet. Barlow's declaration exemplifies the symbiotic relationship between the Internet and libertarian thinking. Barlow's words contain echoes from Locke ("We are forming our own Social Contract."), Mill ("We are creating a world where anyone, anywhere may express his or her beliefs, no matter how singular, without fear of being coerced into silence or conformity."), and Hayek ("our culture, our ethics, or the unwritten codes that already provide our society more order than could be obtained by any of your impositions") (quoted in Barlow 1996, Internet site).

The Internet is, like the U.S. Constitution, designed as an agreement among consenting individuals. It is a set of communication protocols that allow data to be transmitted from one computer to another. Any communication that uses Internet Protocols (IP) can be sent over the Internet. The protocols impose only minimal constraints on the information that can be transmitted. Video, telephony, text, and data all can be sent via IP.

The Internet is also decentralized. No single computer acts as a hub or main distribution point. Instead, like Hayek's spontaneous order, the Internet relies on local information, contained in routing tables, to pass data from any computer on the network to another. Also, the Internet is configured to facilitate anonymity. This tends to shift the balance of power away from government officials and toward individuals. As a result it has proved all but impossible to regulate pornography and junk mail on the Internet.

The Internet was designed to have multiple routes between endpoints, which makes it more difficult both to attack militarily and to regulate. John Gilmore, a libertarian Internet activist, famously said, "The Internet interprets censorship and damage, and routes around it."

Personal computers and the Internet have changed the relationship between individuals and large organizations. One does not need to own a printing press to publish ideas that can reach the masses. One does not need to lease stores to sell goods to people all over the world. One does not need a mainframe computer costing millions of dollars to write a piece of software.

Because individuals are now better able to bypass large organizations, the rationale for government intervention as a check against corporate power has lost its appeal to many people who make a living using computers and the Internet. In *Cyberselfish*, a critical survey of libertarianism in the technology community, the journalist Paulina Borsook wrote that "with geeks, the attitude, mind-set, and philosophy is libertarianism" and "libertarians are the most vocal political thinkers and talkers in high tech" (Borsook 2000, pp. 3 and 7).

Intellectual Property

The low cost of distributing and copying content on the Internet has opened a schism within the libertarian community concerning the issue of intellectual property. Some libertarians argue that intellectual property rights are legitimate, based on Locke's principle that one has a natural right to property created by one's labor. According to this view, if one composes a song or another creative work, one has a property right that should be protected.

Other libertarians, including Barlow, believe that ideas should not to be regarded as property. One person can use an idea without infringing on another person's ability to use that idea. Barlow argues in the tradition of Thomas Jefferson, who wrote, "He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me" (Quoted in Barlow 1996, Internet site).

A potential libertarian approach to the issue of copyright is Digital Rights Management (DRM). The idea behind DRM is that the composer of a creative work would embed in its digital representation a digital "lock" that could be opened only by a consumer who agreed to purchase and use the work within the limitations intended by the author.

However, there are those who doubt that DRM can be effective. Those critics say that the ability of individuals to circumvent DRM will make it impossible to rely on the private sector alone to protect intellectual property. Instead, DRM will require government involvement in the design and enforcement of restrictions on the specifications of equipment. For example, the Digital Millenium Copyright Act (DMCA) criminalized the production of technology that could be used to circumvent copyright restrictions. Many libertarians were troubled by the DMCA.

Biotechnology

The libertarian position on biotechnology, nanotechnology, and other potentially revolutionary scientific developments is one of laissez-faire. The libertarian view is that individuals are capable of addressing the ethical issues raised by new technologies without government interference.

Libertarians tend to dismiss concerns such as those raised by the President's Commission on Bioethics. In *Beyond Therapy* (President's Council of Bioethics 2004) the commission argues that biotechnology poses ethical problems by potentially enhancing human capabilities, eliminating death, and giving parents control over the characteristics of their children. Libertarians believe that individuals are capable of dealing with these issues as they arise. Moreover, libertarians argue that the sort of regulatory regime that would be needed to enforce controls over such technologies would be draconian.

Privacy

Libertarians are mindful of the effect of technology on privacy. Some technologies, such as miniature cameras, radio identification tags, and powerful storage and processing for large databases, seem to threaten privacy. Other technologies, such as the decentralized Internet and cryptography, seem to enhance privacy.

David D. Friedman has painted one scenario for the way these technologies could play out. In Chapter 1 of his draft *Future Imperfect* he writes, "Put all of these technologies together and we may end up with a world where your realspace identity is entirely public, with everything about you known and readily accessible, while your cyberspace activities, and information about them, are entirely private—with you in control of the link between your cyberspace persona and your realspace identity."

The last point—that the individual will control the link between electronic identity and physical identity—is crucial. If the opposite scenario were to emerge, in which the government always would have the ability to trace electronic communications to an individual person, the potential for totalitarian control would appear to be high.

In *The Transparent Society* (1998) David Brin has suggested that the inevitable improvement in surveillance technology is going to cause privacy to be replaced by transparency. Cameras are certain to become smaller, digital radio tracking devices will become more powerful, and all forms of surveillance will become cheaper. In light of this outlook Brin argues that freedom and autonomy can best be preserved by ensuring that individuals have as much access to information about government and large corporations as those organizations have access to information about individuals.

The Future of Libertarianism

In the late industrial age libertarianism went into eclipse. For most of the twentieth century it appeared that the future belonged to powerful manufacturing enterprises and the large government that was thought necessary to regulate and plan the industrial economy. In the Internet age many people are seeing the potential for unplanned order emerging from the decisions of individuals. This has revived libertarianism as an important philosophy.

Libertarianism may have reawakened, but it is far from triumphant. Libertarian approaches to government policy on recreational drugs, education, and health care remain far from the mainstream, where paternalism remains entrenched. Moreover, technology poses problems for which libertarianism, typically absolutist and unabashed, lacks clear answers. Intellectual property poses a conflict between the natural right to own the product of one's labor and the right to engage in free expression and activities that do not infringe directly on another person. New technologies also provide surveillance potential in ways that require libertarians to reconsider the fundamental basis for privacy.

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SEE ALSO *Communitarianism; Democracy; Human Rights; Locke, John; Market Theory; Natural Law; Skepticism; Smith, Adam.*

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LIBERTY

SEE *Freedom*.

LIFE

In consideration of the ethical uses of science and technology the phenomenon of life, especially human life, has repeatedly played significant roles in both progressive and conservative arguments. In modern philosophy notions of life have also made repeated appearances, from Thomas Hobbes's claim that the fundamental aim of politics is to replace the insecurity of life in the state of nature with a more secure life by means, in part, of technology, to Friedrich Nietzsche's appeal to a life ideal that transcends concerns of personal security. Contemporary debates about the limits of biomedical interventions in terms of whether or not human life begins at conception and feminist criticisms of cultural tendencies to disembody life thus reflect and advance long-standing concerns. Indeed, at the beginning of philosophy in Europe, one of Socrates's fundamental theses was that "The unexamined life [*bios*] is not worth living for humans" (*Apology* 38a); and as a manifestation of his divinity, the Christian scriptures record Jesus's claim to being "the way, the truth, and the life [*zoe*]" (John 14:6).

Life Sciences

Science has from its earliest forms distinguished two fundamental realms in nature: the nonliving and the living. Aristotle (384–322 B.C.E.) was among the first systematic investigators of nature and for centuries provided an authoritative orientation that took its bearings from the living. For Aristotle, living entities reveal the workings of nature better than the nonliving; life provides the key to explain the nonliving—in contrast to modern natural science, which seeks an explanation of life in terms of nonlife. Certainly life more clearly displays the dynamism and purposefulness that Aristotle sees as central to reality as a whole. Purposefulness, final causation, and teleology conceptualize that by which entities seek natural states or places proper to their kind. The acorn matures in order to become an oak tree because that is its inner nature; the oak tree maintains its state through metabolism because this inner nature has been achieved. Living things have an internal principle of motion and rest, which can be grasped by reason, whereas the nonliving are moved by external forces, the rationality of which is more difficult to comprehend.

For modern natural science, however, it is the external forces moving nonliving entities that are most readily calculable, thus giving rise to physics in a new sense. René Descartes (1596–1650), for instance, proposed that animals are simply complex machines, and that all life functions (except human thinking) could be explained in terms of mechanical interactions. From the beginning, however, the adequacy of this view has been contested, and the reduction of life to physics and chemistry challenged. The vitalism of Hans Driesch (1867–1941) and Henri Bergson (1859–1941), who argued that life involved some nonphysical element or is governed by special principles, was but one of the more pronounced examples.

Traditional explanations for the variety of life—namely, that either species are eternal or divinely created—and how organisms change over time had long been scrutinized before Charles Darwin (1809–1882) published *On the Origin of Species*. It was Darwin's theory of evolution by natural selection, however, that produced the first comprehensive account of the changing diversity of life that appeared to go beyond simple mechanism without rejecting it. Fused with the model of biological inheritance developed by Gregor Mendel (1822–1884), the synthesis of evolution by natural selection operating on the gene became the cornerstone of modern biology.

In the early 1940s the Austrian physicist Erwin Schrödinger (1887–1961) proposed that genes functioned by means of a "molecular code-script" present in chromosomes. This pointed toward the idea of molecular biology. A decade later, in 1953, James D. Watson (b. 1928) and Francis Crick (1916–2004) discovered the double-helix molecular structure of DNA. Analyses of DNA eventually elucidated the connection between genetic information and the traits of living organisms, which describes the transcription and translation of genetic information into proteins.

Redefining Life

Difficulties nevertheless remain for developing a post-Aristotelian definition of life as a biological phenomenon. One common approach has been to consider an entity living if it exhibits the following characteristics at least once during its existence: growth, metabolism, reproduction, and response to stimuli. Yet in some sense fire meets all these criteria. Moreover, some entities are not clearly either living or nonliving. Chief among these are viruses, which contain protein and nucleic acid molecules that make up living cells but require the assistance of those cells to replicate. In response, life can be further described as cellular and homeostatic—even though this would continue to classify viruses as anomalous.

Systems theorists such as Ilya Prigogine, Fritjof Capra, and Francisco Varela, however, have preferred to define life as a complex, autopoeitic (self-creating), dissipative feedback system. This conception gave rise to the Gaia hypothesis of James Lovelock and Lynn Margulis, which conceives of the entire biosphere as living insofar as it maintains conditions favorable to its continued existence.

What about the possibility of human-made, artificial life? This term can refer to a number of different research programs. Genetic engineering (and even animal breeding) creates forms of life that might not otherwise occur in nature. For Christopher G. Langton computer programs that model life processes by means of complex algorithms constitute artificial life or "a-life." Some theorists go even further to argue that beyond modeling, life is a process that can be abstracted away from any particular medium and need not necessarily depend on carbon-based chemical solutions.

Precisely when human life begins, whether at conception or some point further along in embryonic development, is also a highly contested issue. The premodern view that human life begins at the "quickening"—that is, when a woman experiences the first movements of a new child in her womb—has been altered by the very biological science that often proposes to treat embryos as no different than many other rudimentary organisms.

Life Philosophies

All such modern definitions have difficulty accounting for life as having any intrinsic ethical significance. The purposelessness of natural selection and the lowered status of humans in a hierarchy of being challenge traditional moral and theological beliefs. When life is conceived as an assemblage of adaptations to random and constantly changing circumstances, there remain no forms or essential types to imitate, and no harmonious order or basic good to maintain. Yet despite the most sophisticated explanations, purposefulness does appear to be an aspect of the living.

One response has been the development of a life philosophy (German *Lebensphilosophie*) that arose as a reaction against Enlightenment rationalism. Life is prioritized over mere understanding, and life philosophy has had many variants, including artistic movements in which life is used as a concept to assess and critique modern society. Certainly over the course of the nineteenth and twentieth centuries life as "vitality" or vividness, a sense of both spiritual striving and joyous experiencing, played an important role in literature, art, and music as a touchstone of criticism of the scientific and technological. Among the most important representations of this view are attempts made by Arthur Schopenhauer (1788–1860) and Friedrich Nietzsche (1844–1900) to grasp life as an all-encompassing metaphysical category or first philosophy.

Nietzsche's life philosophy differed from the thought of Schopenhauer in its naturalism. In his genealogical work, he traced the development of the life-denying ascetic ideal that he saw as dominant in Western (and most Eastern) philosophy and religion. Value comes to being always in support of life, but ascetic philosophies give vital ideals a life-devaluing interpretation. Anything that is part of the natural, changing, life-world is interpreted as wrong and sinful, and ideals of truth and virtue are rooted in otherworldly, changeless realms. The ascetic ideal removes all source of value from nature, whereas modern natural science removed any faith in a realm outside of nature. One interpretation of the "death of God" is the extinction of this transcendent, nonhuman, and ahistorical realm to ground human values. There is nothing but life on which to base values, including truth. Whether Nietzsche successfully distinguished this revaluation of values from nihilism remains a subject of dispute.

During the mid-twentieth century life philosophy made a new appearance in the forms of phenomenology and existentialism. Phenomenology especially criticized science as separating itself from the human lifeworld or as disembodying experience. Related arguments have been carried forward in feminist criticisms such as those of Barbara Duden and Donna Haraway. In her studies of women's medicine and experiences such as pregnancy, Duden (1993) defends the primacy of lived experience over its conceptual analysis. In her notion of "companion species," Haraway (2003) criticizes the primacy of conceptual oppositions in favor of mutuality of living relationships, which harks back to the work of Pytor Kropotkin (1842–1921) and his notion of "mutual aid" among organisms.

Whether molecular biology can account for what is apparently goal-directed behavior in organisms likewise continues to spark controversy (see, e.g., Allen, Bekoff, and Lauder 1998). Finally, given the difficulties of understanding the ethical significance of biological life in the modern sense, philosophers such as Hans Jonas (1966) and Leon R. Kass (1985) have even attempted to revive an Aristotelian approach that would understand the most elementary forms of life in terms of higher forms of life rather than vice versa.

The Human Condition, Bioethics, and Biotechnology

According to Hannah Arendt (1958) the life of human activity, or *vita activa,* may be distinguished into labor, work, and action. Labor pertains to the biological processes of the human body, work to the world of artifice, and action to politics. Political action is so central to the human condition that the Romans used the same term (*inter homines esse*) to signify both "to live" and "to be among men." But as Arendt also notes, "life" takes distinct forms in each level of the *vita activa.* In the first instance life is related to the futile, biological labors of the body in which there is a kind of "deathless everlastingness of the human as of all other animal species" (p. 97). In the second instance life takes on the worldliness of work with distinct beginnings and ends and can be told as a story.

The first notion of life corresponds to the Greek *zoe,* from which English derives *zoology;* the second corresponds to the Greek *bios,* from which comes *biography* and a sense of the historical. For Arendt the modern world may be characterized by an effulgence of *zoe* as labor moved from the most-despised to the most-esteemed position with a productivity that outstripped all traditional work and overwhelmed action. But action and speech, beyond the necessary but lower forms of the *animal laborans* (labor) and *homo faber* (work), is the highest form of human life. The measure of all things, she claims, "can be neither the driving necessity of biological life and labor nor the utilitarian instrumentalism of fabrication and usage" (p. 174).

The term *bioethics* was initially coined by the biologist Van Rensselaer Potter (1911–2001) to refer to an ethics grounded on the science of life, rather than on religion or philosophy. It has since come to signify the field that studies the intersection of biology and biography, or the science of life studied scientifically and life lived experientially (Kass 2002). The focus on biography and the good life, rather than mere biological life, has taken on more importance as new biomedical technologies expand the capacities of human biology, or what Arendt would call the labor of human bodies. This is best illustrated by advances in life-extending techniques used in palliative care. In many instances, one's biological life is extended well beyond the duration of one's biographical life among the world of things and within the plural realm of action and speech. This raises ethical questions about what it means to die a dignified death and who should make such decisions in various circumstances.

Advances in biotechnology offer new powers to alter and to some degree control the phenomena of life. This has brought both reward and risk. In agricultural uses, biotechnology has raised concerns about risks, especially involving uncertain ecological interactions and health effects. In biomedical uses, similar health risk issues occur along with questions of informed consent and privacy. Additionally, the controversial techniques of abortion, cloning, and stem cell research sustain heated debates about when human life begins. New reproductive techniques have stimulated questions about how much control the present generation ought to have over future generations.

This last issue highlights the fact that both in agricultural and medical biotechnology, traditional ethical issues are complemented by deeper concerns about the proper limits to the human activity of "remaking Eden" and "relieving man's estate." How ought humankind responsibly exercise its power over life and where should limits be drawn? For example, even though biomedical technologies offer obvious rewards in terms of satisfying deep human desires, they can also serve (intentionally or not) to diminish human life. As the President's Council on Bioethics remarked in *Beyond Therapy* (2003), "To a society armed with biotechnology, the activities of human life may come to be seen in purely technical terms, and more amenable to improvement than they really are" (p. xvii). Promoting the genuine flourishing of human life is foremost a matter of understanding the good life rather than commanding the tools to manipulate life processes.

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SEE ALSO *Bioethics; Environmental Ethics; Medical Ethics.*

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LIMITED NUCLEAR TEST BAN TREATY

The Limited Nuclear Test Ban Treaty (LTBT) was signed by the United States, Great Britain, and the Soviet Union in Moscow on August 5, 1963. Ending more than eight years of negotiations, the LTBT prohibits nuclear weapons tests or other explosions in the atmosphere, outer space, or underwater. While the treaty does not ban underground nuclear explosions, it does prohibit tests if they would cause "radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control" the explosions were conducted. In addition, by signing on to the treaty the countries agreed to the goal of "the discontinuance of all test explosions of nuclear weapons for all time."

Emergent History

After the end of World War II, Great Britain and the Soviet Union joined the United States in the nuclear club and the United States and the Soviet Union tested their first hydrogen bombs in 1952 and 1953 respectively. Public concern about nuclear testing began to grow, especially after the March 1954 test of a thermonuclear device by the United States at Bikini atoll. This test was expected to have a yield equivalent to approximately eight million tons of trinitrotoluene (TNT), but in actuality was about fifteen megatons, or almost double the predictions. The fallout from the explosion greatly exceeded geographical expectations, contaminating a Japanese fishing vessel, the Lucky Dragon, as well as Bikini atoll.

This incident, as well as others, increased the awareness of the effects of fallout and the issue of continued nuclear tests garnered greater public scrutiny. Organizations such as Women Strike for Peace and Physicians for Social Responsibility were formed to increase public pressure on western governments for signing a treaty, as well as informing the public of the dangers of nuclear testing. For instance, Women Strike for Peace originated from an international protest of women against atmospheric testing. Physicians for Social Responsibility documented the presence of strontium-90—a highly radioactive waste product of atmospheric nuclear testing—in children's teeth across the country. As it became apparent that no region of the world was untouched by radioactive fallout, there was increasing apprehension about the possibility of global environmental contamination and the resulting genetic effects. It was in this atmosphere that efforts to negotiate an end to nuclear tests began in May 1955 in the Subcommittee of Five of the United Nations Disarmament Commission.

International interest in the course of the negotiations was intense and sustained. The issue was brought up in statements and proposals at international meetings and the United Nations General Assembly addressed the issue in a dozen resolutions, repeatedly pressing for an agreement to be reached. While the United States, Great Britain, and the Soviet Union engaged in a tripartite effort—The Conference on the Discontinuance of Nuclear Weapons Tests—almost continuously from October 31, 1958 to January 29, 1962, no treaty could be drafted due to differences on a number of issues.

Basic Treaty Issues

The issue of a control and enforcement mechanism to verify compliance to a comprehensive test ban was the primary point of disagreement between the parties. Western European and U.S. powers, especially, were concerned that it would be more dangerous to accept pledges without the means to verify that they were being complied with than to not have a treaty at all. The Soviets, for their part, felt that because, "in the present state of scientific knowledge" (Premier Bulganin writing to President Eisenhower on October 17, 1956, from U.S. Department of State Bureau of Arms Control) no explosion could be produced without being detected, then there could be an immediate agreement to prohibit tests without an international control mechanism at all.

To resolve the issue of how compliance could best be verified, the Geneva Conference of Experts met in July and August 1958 and was attended by representatives from the United States, Great Britain, Canada, France, the Soviet Union, Poland, Czechoslovakia, and Romania. The group of experts developed and agreed on the technical aspects of a verification system to monitor a ban on atmospheric, underwater, and underground tests. This control system included an elaborate network of more than 150 land control posts, ten ship-borne posts, and special aircraft flights. In addition it allowed for on-site inspections to determine whether seismic events were caused by earthquakes or by explosions. While the United States and Great Britain said they would be willing to negotiate an agreement based on the establishment of an international control system, the Soviet Union responded by linking the test ban to other arms control issues and resumed testing. The other nuclear powers refrained from testing until 1961, after France tested its first nuclear weapon in 1960, and in 1962, the four nuclear powers conducted a record 178 nuclear tests.

Disagreement on a control system was focused on four main areas:

(a) The Veto. The Soviet Union wanted all operations to be subject to a veto while the United States maintained that the inspection process should be automatic in order to be effective.

(b) On-Site Inspections. The Soviet Union capped on-site inspections at three per year while the United States and Great Britain insisted that the number should be determined by detection capability and necessity. Eventually the United States said it would accept a minimum of seven inspections, which was rejected by the Soviet Union.

(c) Control Posts. Neither side could agree on the number and location of posts or of the automatic seismic observation stations that would supplement nationally owned control posts. The argument of the Soviet Union that these national posts and observation stations would make inspections unnecessary was rejected by the United States and Great Britain.

(d) The Organization and Control Commission. The Soviet Union proposed a *troika* of administrators for the Control Commission, including one neutral, one Western European or North American, and one Communist member. The Western European and North American countries argued that this would make the Control Commission powerless and unable to take action. The Soviet Union eventually acquiesced to opposition concerns and abandoned this position.

Treaty Creation and Ratification

After the Cuban Missile Crisis in October 1962, both sides were anxious to alleviate public fears about nuclear weapons and therefore restarted the three-power conference on a test ban treaty in July 1963. While the Soviet Union would not agree to a treaty that prohibited underground testing, the three powers were able to agree on a partial ban on atmospheric, outer space, and underwater testing, which were all easily verifiable without intrusive inspections. In just ten days, the three parties had developed and signed the LTBT. The U.S. Senate ratified the agreement on September 24, and President John F. Kennedy signed the LTBT into law on October 7, 1963. The LTBT formally entered into force on October 10, and it is of unlimited duration.

Although the LTBT was touted by all parties as a success, and indeed it was so as it greatly reduced dangerous atmospheric fallout and deadly radiation, including strontium-90, secondary results were mixed. Because neither France nor China signed the LTBT, they continued to test intermittently until the early 1980s. India, Pakistan, and Israel, all signatories of the treaty, were able to join the nuclear club despite the limited ban. And in the United States and the Soviet Union, nuclear weapons development and testing continued unabated, although all tests were moved underground. Additionally there was less international public pressure to develop a comprehensive test ban treaty as the most visible sign of the arms race, atmospheric testing, was eliminated. However despite these failings, the LTBT was an important and symbolic first step and served as a precedent for future arms control treaties.

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SEE ALSO *Baruch Plan; International Relations; Nuclear Ethics; Nuclear Non-Proliferation Treaty; Weapons of Mass Destruction.*

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LIMITS

The question of human limits, both cognitive and moral, is a persistent theme in the history of religion and philosophy. Both Siddhartha Gautama (Buddha, c. 563–c. 483 B.C.E.) and Socrates (469–399 B.C.E.) argued, in quite different ways, for the human acceptance of limits. Indeed, in general premodern traditions in human culture widely acknowledged both theoretical and practical limits on human knowledge and action.

Thus ever since the founding of modernity, with its appeals to transcend many traditional limits in the development of science and technology—and even certain aspects of the human condition—the question of whether and to what extent there might be new limits to the modern project has been a recurring theme. Late eighteenth and early nineteenth century poets such as Johann Wolfgang von Goethe (1749–1832) and William Blake (1757–1827) called for recognition of cognitive limits in modern science; nineteenth and early twentieth century novelists such as Charles Dickens (1812–1870) and John Steinbeck (1902–1968) argued for placing social and political limits on industrial technological practices; and philosophers of limits such as Karl Marx (1818–1883), Friedrich Nietzsche (1844–1900), and Oswald Spengler (1880–1936) proposed the existence of historical and cultural limits to modern development as a whole.

Limits to Growth

Such general discussions were given a new, specialized form with the 1972 publication of *The Limits to Growth* by the team of Donella Meadows, Dennis Meadows, and Jørgen Randers, which brought the environmental predicament of industrial progress to the attention of a world audience. On the basis of a computerized world model, the celebrated but controversial study claimed that continuing high rates of growth would lead to (a) a depletion of vital global resources, (b) increasing pollution, and (c) population outrunning the world's potential food supplies. The study suggested that, unless swift action was taken, absolute limits to growth would appear in the course of the twenty-first century, causing population size and industrial capacity to drop rapidly. This message was instantly seen as a blow against the creed of economic growth dominating at the time, both in the Western and the Communist world. Subsequently, the rift between growth advocates and growth skeptics has continued to divide the contemporary world of science and of politics; in fact, this division reaches deeper than conventional distinctions such as conservative/progressive or right/left.

Do Limits Exist?

The debate on limits carries on where classical economics had left off. Thomas Malthus (1766–1834), for example, still had the implicit vision of the Earth as a closed space, with limits to the size of population and level of human achievement it could sustain. He argued that lack of food supply would ultimately constrain population growth, throwing into doubt the idea of the inevitability of progress. However, he underestimated both the variability of growth and the capacity of technology to overcome natural limits. In contrast, neo-classical economics, operating on the background assumption of the infinite power of science and technology, had subsequently ignored the dependence of economic systems on natural systems completely. This shortcoming had left economic science blind to the impending environmental crisis in the twentieth century.

The attempt of Meadows, Meadows, and Randers to expose this failure set off a replay of the controversy between the "closed space" and "infinite ingenuity" schools of thought. While the former insists on the finiteness of both resource inputs and waste sinks, the latter emphasizes the practically infinite substitutability of natural resources by technology and organizational innovation (Simon 1981). What matters to the biosphere is the scale of resource flows, not just their efficient allocation (Daly 1996). Markets may reduce the volume of resource use through substitution of natural inputs, but continuing growth will eventually cancel out these efficiency gains, increasing volumes again. It is the overall scale of resource flows with respect to both input sources and waste sinks that determines the relationship between the economy and the biosphere.

Scientific findings suggest that for the first time in history, human-induced material flows are presently outgrowing nature-induced flows. In other words, the technosphere eclipses the biosphere. Some well-known facts are symptoms for this imbalance: Humankind has already exhausted 40 percent of known oil reserves, transformed nearly 50 percent of the land surface, appropriates more than half of all accessible freshwater, increases greenhouse gases in the atmosphere over and above natural variability, and causes extinction rates to increase sharply in marine and terrestrial ecosystems (Steffen et al. 2004, p. 6). In general terms, human impacts on the Earth are approaching or exceeding in magnitude the impact of some of the great forces of nature. In addition, they operate on much faster time scales than rates of natural variability. Estimates following the ecological footprint methodology imply that human activities presently exceed the Earth's capacity by 15 to 20 percent—without taking the needs of other living beings into account (Wackernagel et al. 2002). Ecological overshoot has become the distinguishing mark of human history.

What To Do about Limits?

The way "limits" are understood has consequences for politics and ethics. One metaphor for conceptualizing limits is that of a cliff face: The concept implies a fixed line beyond which collapse looms. It insinuates that crucial changes happen in an abrupt as well as catastrophic fashion, making everyone suffer equally. However, changes may also occur in a gradual as well as insidious fashion, and may burden some more than others. A metaphor based on a tapestry—each act of destruction is like pulling a thread from the tapestry—would emphasize linear and not just non-linear processes, multiple smaller losses and not just overall collapse. In particular, it would highlight the presence of political choices along the gradient of degradation (Davidson 2000). The tapestry metaphor, more than the cliff metaphor, encourages one to judge wreckage not only as prelude to the collapse, allows one to trace the differential impact of losses on social groups, and stimulates the politically and ethically essential question: What thresholds are considered tolerable/intolerable for whom and on what grounds?

Thresholds of ecosystem changes represent "limits" only for humans; any definition of limits is therefore a political act. Moreover, limits are rarely scientifically knowable; their definition is therefore an ethical act as well. As a consequence, any definition implies choices in terms of human welfare, equity, and the common good. A first approach centers on risks, putting the spotlight on possible physical, technical, and economic losses resulting from the technology or economic policy in question. Emphasis is placed on the precautionary principle of preventing the worst from happening. Guardrails, for instance, are suggested in order to avoid abrupt and irreversible changes from which human societies would find it difficult or impossible to recover (German Advisory Council on Global Change 1997).

A second approach focuses on institutions, because the rise of external limits is brought about by structures of growth and accumulation that are internally insatiable and limitless. This approach highlights the constellation of social and economic factors driving perilous developments (Harvey 1996). Proposals range from the reform of price structures to the containment of the profit motive, from the reallocation of research funds to the phase-out of certain technologies.

Finally, a third approach calls for a reconsideration of values, bringing into sharp relief the civilizational losses incurred by the predominance of the logic of growth. Natural limits are often preceded by the appearance of social and cultural limits; before growth causes physical perturbations, collective and individual well being has suffered (Illich 1973, Hirsch 1976). Recognizing limits, therefore, implies the emergence of fresh opportunities by restoring a balance. In this approach, limits acquire a positive connotation, making a more accomplished life possible. They turn out to be productive for a civilization that regards economic power and growth only marginally important.

WOLFGANG SACHS

SEE ALSO *Ecological Footprint; Precautionary Principle.*

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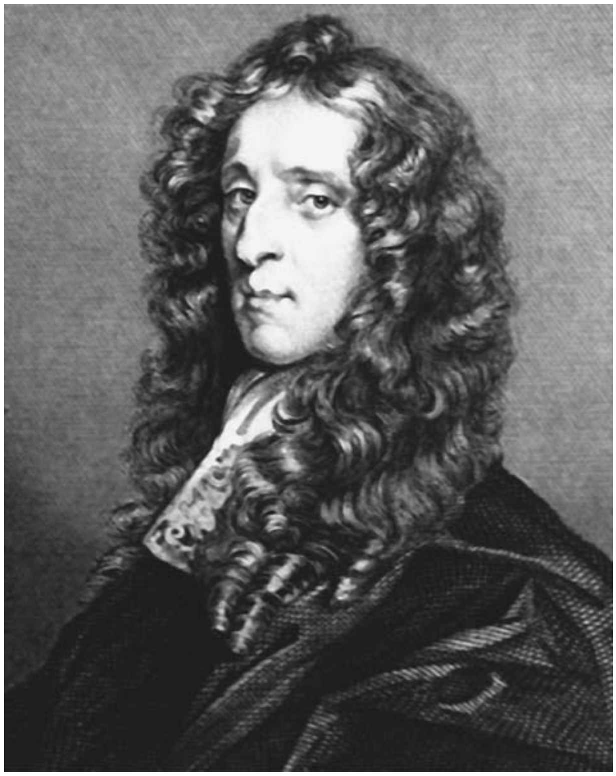
LOCKE, JOHN



John Locke, 1632–1704. An English philosopher and political theorist, Locke began the empiricist tradition and thus initiated the greatest age of British philosophy. He attempted to center philosophy on an analysis of the extent and capabilities of the human mind. *(Rutgers University Library.)*

John Locke (1632–1704), was an English philosopher, Oxford academic, and occasional bureaucrat. He was born at Wrington, Somerset, on August 29 and died at Oates, Essex on October 28. Locke's fame as a philosopher rests chiefly on two works: *An Essay Concerning Human Understanding* (1689) and *Two Treatises of Government* (1689). The former became a chief textbook of the European enlightenment and subsequent philosophy. The latter deeply influenced both the Declaration of Independence (1776) and the Constitution of the United States (1787), a document that made promoting the "progress of science and useful arts" one of its distinguishing features (Article I, section 8). These facts establish his reputation as one of the most influential modern philosophers and signal his importance in issues related to science, technology, and ethics.

Locke's strategy in his two most influential works is characteristic of early modern thought. First he sets out to clear away errors and conceits left over from classical and medieval science. Next he reduces the subject to its most basic natural constituents, as yet unmodified by culture. Only then does he set about reconstructing new systems of epistemology and political philosophy.

The *Essay*

Part One of the *Essay* is devoted to a refutation of the doctrine of innate ideas, according to which all human beings are born with certain principles already stamped upon their minds. It might seem doubtful that the importance of this doctrine justifies the attention that Locke devotes to it; however, its demolition whets the appetite for a more satisfactory account of the mind.

Locke holds to the view that all human ideas are reducible to experiences, a doctrine known as *empiricism*. An *idea* here means anything in the contents of the mind that is definite enough to have a name. Impressions, such as *hot* and *red*, received from the external world are the primary source of ideas. But unlike more uncompromising empiricists, such as David Hume, Locke admits of a second source of ideas: reflection upon the operations of human minds. One may observe what the mind does with the material provided by sensation and so acquire ideas of *thinking*, *willing*, and the like. So, though there are no innate ideas, there are innate sources of information.

Some ideas, such as *hard* or *perception* are indivisible. These are received passively by the mind. But the mind can also act on elementary ideas in three ways: by combining several into one complex idea; by comparing one with another; and by abstracting some idea from the setting in which it actually occurs. By such operations the mind can furnish itself with a potentially unlimited stock of complex ideas. These in turn fall into three categories: *relations* between ideas, *substances* that may exist on their own; and *modes* that exist only in something else. Thus the sun is a substance; it is bright in relation to terrestrial fire; and its brilliance is one of its modes.

Though all complex ideas are products of the mind, they can be anchored in the real world. A substance is known only by its qualities, which are the impressions it makes on the senses. Its primary qualities belong to it independently of observation, so a stone has weight and shape whether anyone perceives it or not. Secondary qualities depend on an observer. The stone is brown only in the right light, and in the eyes of some beholder. One cannot conceive but that these qualities subsist in some underlying thing, but has no idea of what that thing is. Locke subscribes, however, to the corpuscular or atomic theory of matter and supposes that the substratum consists of invisibly small particles.

Locke's philosophy of mind narrows the distance between speculation and technology. Chemistry, once it has purged itself of any alchemical conceits and has arrived at knowledge of the elements, not only understands the world better but provides human beings with means to manipulate it. Similarly Locke offers both a better account of human knowing and a set of useful instruments both for scientific and philosophical investigation.

This raises the question of the rank of philosophy with respect to science and technology. In one respect Locke's view of this matter seems closer to the medieval than to the classical conception. For the Greeks, philosophy was more elevated and more complete than any science, if indeed it did not incorporate all the sciences. In medieval scholarship, philosophy is famously regarded as the *handmaiden of theology*, usually in so far as it supports and clarifies faith. For Locke, philosophy seems to become the handmaiden of the sciences.

In the Epistle to the *Essay* Locke distinguishes between the *Master-Builders* and the *Under-Labourers* of the sciences. Among the former are Robert Boyle, Thomas Sydenham, Christiaan Huygens, and Isaac Newton, whose works stand as monuments to posterity. Locke counts himself among the latter, whose job it is merely to clear the ground and remove the rubbish that obstructs the advance of science. If this is Locke's view, he has reduced philosophy to a preparatory exercise, much of which is necessary only because of the abuses of language committed by psuedophilosophers. Locke's *Essay* is certainly similar to contemporary academic philosophy, which understands itself as clarifying questions up to the point that science can get a grip on them.

The scientists named by Locke are conspicuous for both theoretical and technological achievements. Boyle constructed an air pump; Newton and Huygens built advanced telescopes; Sydenham pioneered new medical treatments. But it is clear that for Locke their greatness lay more in their theoretical work than in any useful devices they may have contrived. He shows no inclination to subordinate the sciences to technology. A few lines after mentioning Newton, he identifies philosophy as "nothing but a true knowledge of the nature of things" (Locke 1975, p. 10). Whatever Locke's view of his business in the "Essay," he had a view of philosophy broad enough to encompass the sciences. It is closer to the classical view than is often supposed.

The *Two Treatises*

In his *First Treatise*, Locke demolishes Robert Filmer's argument in favor of the divine right of kings. This sets the stage for the *Second Treatise*: If political authority does not originate in God's appointment of Adam, then its origin must be sought in human nature.

Typically Locke identifies and isolates the elementary building block of political societies: This is the human being in the *state of nature*. The latter indicates a condition of perfect freedom and equality, with no one having any authority over another. But it is not, as Thomas Hobbes (1588–1679) supposed, a state of license. For there is a natural law available to all human beings, directing them to respect one another's life, liberty, and property.

Oddly enough, it is not viciousness that requires the formation of governments, but the human capacity for righteous indignation. In the state of nature, each person is entitled to punish any transgression of rights. But as each person judges primarily in his or her own favor, one person's enforcement of natural law is another's transgression of the same. Thus the universal distribution of the executive power can lead to endless cycles of revenge. The way to avoid this is for all to surrender their portions of the executive power to some common judge, to whom appeal may be made in case of conflict.

Human beings thus leave the state of nature in order to more securely enjoy those rights that they possessed while still in it. Universal consent is the foundation of political authority, which may be invested in such forms (for example, kings and parliaments) as the subjects think fit. However that grant of authority is always conditional rather than absolute. When the government forfeits the consent of its subjects, or by aggression or neglect fails to protect their liberties, it effectively abdicates. The people are then entitled to abolish it and form a new one.

Property Rights

Locke's theory of property, set forth in Chapter 5 of the *Second Treatise,* is among the greatest achievements of seventeenth-century political and economic thought. Here Locke cuts to the original position immediately: In the beginning all things belonged equally to all human beings, and each had leave to take from the earth whatever he or she needed. What then is the origin of any private rights to property?

Each person has ownership of his or her own body and labor. In order for some external good such as food to be enjoyed it must sooner or later be appropriated. After an apple is consumed it joins with the perfect privacy of the flesh. Locke argues that the moment of appropriation comes when someone's labor is mixed with the bounty of nature. When acorns are first gathered from the wild, they become private property. The right of appropriation is universal, the only limit is that one may gather only what one can use.

Locke weds this account with a theory of economic progress, which includes in turn a labor theory of value and a theory of money. The greater part of the value of any product originates in the labor required to produce it. Invested in a loaf of bread, for example, is a plowed and cultivated field, harvested and milled wheat, a bricked and furnished bakery. All this labor represents a vast increase in the wealth available to humankind over what unimproved nature provides.

But how is it possible to encourage people to labor beyond what their needs require or the durability of their produce allows? The answer lies in money, the exchange of the products of one's labor for some durable medium of nominal rather than real value. When someone settles and improves a piece of land, it is taken out of the common stock; however, in return for money, the settler gives back more value than he or she took away. Locke understood that this process, repeated across a wide range of industries, was an engine of unprecedented economic growth. For that reason, one of the most important ends of government was the protection of private property.

Locke's theory of property may be set comfortably in the context of a fundamental modern project: the conquest of nature. The natural world is not charitable to human beings. It provides little of what they need in advance of their labor. But the potential wealth that exists in nature is vast beyond calculation. Thus the aboriginal inhabitants of America who, Locke says, "are rich in land but poor in the comforts of life" exemplify the situation of human beings in the state of nature (Locke 1988, p. 296). By encouraging labor, a system of money and property rights will result in the most thorough cultivation of nature, for the comfort of all humankind.

It is clear that Locke's approach to all three topics elevates the products of human invention far above the natural materials from which they are fashioned. Complex ideas are more interesting and useful than simple ones. There is both more security and more freedom under government than out from under it. If a government acts to protect property rights, human beings will then make whatever they need to relieve the poverty into which the species was born. Nature will be reduced to a storehouse of useful materials.

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SEE ALSO *Hume, David; Liberalism; Libertarianism; Mill, John Stuart; Skepticism.*

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LOGICAL EMPIRICISM

Logical empiricism (LE) is a term that was coined by the Austrian sociologist and economist Otto Neurath (1880–1945) to name the philosophical work of the Vienna Circle and related work being pursued by the physicist and philosopher Hans Reichenbach (1891–1953) and his associates. Related terms include *logical positivism*, *neopositivism*, and *scientific empiricism*. The basic intention of LE was to formulate a scientific philosophy for understanding the relationship between science and society. In historico-philosophical terms the aim was to combine the empiricist legacy of philosopher-scientists such as Hermann von Helmholtz (1821–1894), Ernst Mach (1838–1916), Henri Poincaré (1854–1912), and Pierre Duhem (1861–1916), with the new logic developed by Gottlob Frege (1848–1925), David Hilbert (1862–1943), and Bertrand Russell (1872–1970). The intended synthesis was not simply a theoretical project. Logical empiricists considered themselves part of a progressist movement for a more rational and enlightened society. As stated in the so-called Manifesto of the Vienna Circle, LE aimed to foster a "scientific world-conception" ("wissenschaftliche Weltauffassung") that would help create a better world for all people.

The Scientific World-Conception

The characteristic method of LE was logical analysis, which used mathematical logic to clarify the logical structure and meaning of assertions. In this way LE aimed for a logical analysis of scientific and philosophical language that would distinguish clearly between meaningful and meaningless sentences; fight against metaphysics, which was considered as a hotbed of meaningless "pseudo-sentences"; and provide a "unified science" (*Einheitswissenschaft*) that would be formulated in a logically analysed language cleansed of metaphysical elements.

LE claimed that logical analysis demonstrated that there are only two kinds of meaningful propositions, the analytic a priori propositions of logic and mathematics and the synthetica posteriori propositions of empirical sciences. All other assertions were to be considered cognitively meaningless. This holds in particular for all metaphysical propositions. The most famous argument to this effect is found in "Overcoming Metaphysics by Logical Analysis of Language" 1932 by Rudolf Carnap (1891–1970). Moreover, "overcoming metaphysics" was not simply an internal philosophical issue because logical empiricists considered metaphysics to be a medium for propagating politically and morally pernicious ideologies that had to be fought not only in the academic sphere but also in the political arena.

Politically, most logical empiricists were democratic socialists or unorthodox Marxists and thus were partisans of an "engaged scientific philosophy." A few, such as Moritz Schlick (1882–1936) and Friedrich Waismann (1896–1959), were less political but shared a progressive, liberal outlook.

For all logical empiricists scientific philosophy was a collective enterprise that had to contribute to the construction of a modern, enlightened society. That task was to be carried out in close collaboration with the sciences and other progressive cultural forces, such as the artists and architects belonging to the *Neue Sachlichkeit* movement or the Bauhaus. When LE was at its peak in the late 1920s and early 1930s, the more radical logical empiricists of the Vienna Circle, such as Neurath and Carnap, regarded themselves as "social engineers" engaged in the task of forging the philosophical and scientific tools for building a new socialist society. This is expressed emphatically in the concluding lines of the *Manifesto of the Vienna Circle*: "We witness the spirit of the scientific world-conception penetrating in growing measure the forms of personal and public life, in education, upbringing, architecture, and the shaping of economic and social life according to rational principles. The scientific world-conception serves life, and life receives it" (Sarkar 1996, Vol. I, pp. 329– 330).

LE included a multifaceted and variegated group of philosophers and scientists. Its internal diversity often is underestimated. LE was less a school with a common doctrine than a movement whose members shared vaguely progressist convictions. Even closely related thinkers such as Carnap and Neurath disagreed on many basic philosophical issues. Here the focus is on few leading figures of the Vienna Circle: Schlick, its founder; Carnap and Neurath; and Carl Gustav Hempel (1905–1997), the most influential representative of LE in the United States.

In the early 1930s the LE movement in Europe gradually dissipated as a result of disastrous, political developments and indivdual events. The mathematician Hans Hahn (1879–1934), considered by some to be the "real" founder of the Vienna Circle, died in 1934, and Schlick was murdered by a demented student in 1936. In 1934 Carnap left Vienna and moved to the German university in Prague. After the rise of National Socialism in Germany (1933) and clerical fascism in Austria (1934) most logical empiricists emigrated. The majority went to the United States, including Carnap, Reichenbach, and Hempel. The history of LE thus divided into two periods: a European period ending in the mid-1930s and an Anglo-American period from the 1930s until its dissipation in the 1960s.

Major Figures and Their Ideas

The founder and official leader of the Vienna Circle was Schlick, who studied physics under Max Planck (1858–1947). Later Schlick turned to philosophy, and in 1922 he was appointed to the chair of natural philosophy at the University of Vienna as the sucessor to Ludwig Boltzmann (1844–1906) and Ernst Mach (1838–1916). Beginning in 1923, he and his assistants Herbert Feigl (1902–1988) and Friedrich Waismann organized a discussion group (first called the "Schlick circle") that soon became known as the "Vienna Circle."

Schlick had begun as a "critical realist", and later was influenced by Ludwig Wittgenstein (1889–1951). In *The Turning-Point in Philosophy* (1930) Schlick emphatically endorsed Wittgenstein's thesis that the philosophy of science is not to be considered a system of knowledge but instead a system of acts: "[P]hilosophy . . . is that activity whereby the meaning of statements is established or discovered. Philosophy elucidates propositions, science verifies them" (Sakar 1996, vol. II, p. 5). This entailed the idea that only propositions that are meaningful can be verified. Philosophy, as philosophy of science, thus is left with the task of explaining what is meant by verification. Following Wittgenstein, Schlick proposed that the meaning of a proposition is established by its method of verification, that is, method for determining whether it is true or false. Formulated negatively, a proposition for which no verification procedure can be imagined is a meaningless pseudo-sentence.

The principle of verifiability initially appears to be quite plausible. However, it turns, out to be impossible to construct a definition that would classify all the statements of empirical science as meaningful while disqualifying all metaphysical assertions as meaningless. Even if it was easy to formulate criteria that rendered meaningful observational statements such as "it is cold outside now," it turned out to be extremely difficult to distinguish in a principled manner meaningful scientific statements such as "all electrons have the same charge" or "f = ma" from meaningless metaphysical pseudo-statements such as "the absolute is perfect".

Probably the best-known representative of LE is Carnap; there is even a misleading tendency to identify LE with Carnap's philosophy. Carnap began his philosophical career as a neo-Kantian with *The Logical Structure of the World (Der Logische Aufbau der Welt)* (1928), which proposed constitutional theory as a scientific successor to traditional epistemology and philosophy of science. Constitutional theory was to be a general theory of rational reconstruction of scientific knowledge in the logico-mathematical framework of Alfred North Whitehead (1861–1947) and Bertrand Russell's (1872–1970) *Principia Mathematica*. In informal terms the constitution of a concept provides coordinates that determine its logical place in a conceptual system.

Subsequently, Carnap replaced constitutional systems with more empiricist constitutional languages and pursued the philosophy of science as the study of the structure of the languages of science. According to Carnap, the task of philosophy is to construct linguistic and ontological frameworks that can be used in the ongoing progress of scientific knowledge. In *Testability and Meaning* (1937) he argued that philosophy should not formulate its principles as assertions such as "All knowledge is empirical" or "All synthetic sentences that we can know are based on experiences" or the like—but rather in the form of a proposal or requirement. By such a formulation, he maintained, "greater clarity will be gained both for carrying on discussion between empiricists and anti-empiricists as well as for the reflections of empiricists" (Sakar 1996, Vol. II, p. 258). Throughout his philosophical career Carnap saw the task of logical empiricist philosophy of science as formulating a general theory of linguistic frameworks to provide conceptual tools for the enhancement of science and philosophy, as already had been done implicitly in the 1929 manifesto.

The sociologist, economist, and philosopher Neurath was the most radically "engaged philosopher" in the Vienna Circle. He was the driving force behind the rapid change from an academic discussion group to an international philosophical movement that eventually was to dominate the philosophy of science in the mid-twentieth century. A pitiless fighter against traditional metaphysics, Neurath made his most important positive contribution to the scientific world-conception in the form of the project of "unified science."

In contrast to the essentially negative program of eliminating metaphysics, the project for a unified science is the great constructive paradigm of LE. According to Neurath, scientific knowledge does not have the form of an all-embracing deductive system but constitutes an encyclopedia. According to encyclopedism, as he termed his account, scientific knowledge has the following five characteristics: It is fallible, pluralistic, holistic, and locally but not globally systematizable, and it is not an image of the real world. Neurath conceived the encyclopedistic project as a large-scale politico-scientific and philosophical program aimed at the highest possible level of the integration of the sciences without succumbing to the temptation of an exaggerated rationalism that would force the sciences into the straihtjacket of a metaphysical system.

The foundation for Neurath's encyclopedism was a robust physicalism according to which all concepts can be defined ultimately and entirely in terms of physicalist concepts and/or the concepts of logic and mathematics. Physicalist concepts are not simply the concepts of physics but instead are the concepts of everyday language dealing with middle-sized spatio-temporally located things and processes. Physicalist language, cleansed of metaphysical phrases and enriched by scientific concepts, was conceived as a mixed language containing precise and vague terms side by side. Depending essentially on the concrete practices of everyday life, Neurath's encyclopedism turned scientific knowledge into historically and socially situated knowledge. This had strong implications for its form. Instead of the "pseudorationalist" conception of a timeless objective "system" of knowledge that would create a picture of the world "as it really is," Neurath put forth a more flexible, nonhierarchical encyclopedia as the appropriate model for human knowledge.

Although Neurath's account of LE is the version most congenial to science, technology, and social studies, this has not been recognized widely. One reason for this misunderstanding is Neurath's death in 1945, which made it impossible to promote his version of LE in the Anglo-American world. Since the 1980s, however, Neurath's vision has received a considerable reconsideration in both the United States and Europe.

Carl Gustav Hempel was Reichenbach's student in Berlin but also spent time in Vienna. After emigrating to the United States via Belgium he became Carnap's assistant in 1937. He began his philosophical career with a dissertation on the logical analysis of the concept of probability. In the 1950s and 1960s he became the most influential logical empiricist in the English-speaking philosophical community. His papers set a standard for the logical analysis of concepts. For instance, his contributions to the theory of scientific confirmation and explanation, especially the covering-law model, determined the agenda of analytic philosophy of science for decades. His "Fundamentals of Concepts Formation in Empirical Science" (1952) served as an introduction to philosophy of science for generations of students.

Hempel was particularly engaged in pointing out difficulties and paradoxical features in many core concepts of the philosophy of science, arguing for the necessity of a thoroughgoing logical analysis. The "raven paradox" is a famous example: If it is a law of nature that all ravens are black, the observation of a black raven may count as a (partial) confirmation of this law. Moreover, it is reasonable to assume that laws of nature should be independent of their logical formulation. Thus, the law that all ravens are black has the logical form "All R are B," which is logically equivalent to "All non-B are non-R." With this conceded, a green frog, as something that is not black and not a raven, counts as a (partial) confirmation of the original law. However, this is absurd. Hence, something in the conception of natural law and confirmation seems to be wrong. The raven paradox shows that philosophers do not understand even the most basic concepts in the philosophy of science fully.

Hempel's philosophical work was characterized by a careful and circumspect application of modern logic that made the achievements of logical analysis attractive even for those who were not professional logicians and philosophers. For instance, *The Function of General Laws in History* (1942) exerted influence far beyond the confines of philosophy. It is one of the few LE analyses that has had an impact in the humanities. In *Problems and Changes in the Empiricist Criterion of Meaning* (1950) Hempel further criticized the various logical empiricist attempts to formulate a waterproof criterion for distinguishing meaningful and meaningless assertions. In later years Hempel was influenced by Thomas Kuhn (1922–1996), belying the claim that LE and historical accounts of science are necessarily opposed.

Assessment

A special problem in LE is the transformation of the movement when the intellectual exodus from Europe to the United States took place in the 1930s. The transplantation of LE did not leave its philosophical content unaffected. Although a comprehensive history of LE has not been written, important differences between the two versions can be noted easily. European LE was politically much more radical than its U.S. successor. Although the Vienna Circle showed a vigorous interest in political and social issues such as education, technology, architecture, and art, in the United States the political dimension of LE became less visible. For instance, Carnap was a dedidated supporter of the civil rights movement until the end of his life.

One factor in this change from a radically "engaged scientific philosophy" to an academically confined "philosophy of science" is surely the fact that logica empiricists had to adapt to a different political and societal context in which the application of their traditional political categories was difficult. Another reason may have been that to survive in exile it was expedient to use a language that was more cautious than that which was acceptable in the "Red Vienna" of the late 1920s. After all, LE started in the United States among a rather obscure philosophical group of emigrants without much of a reputation. Only gradually did it become the mainstream in Anglo-American philosophy of science and epistemology in the 1940s and 1950s.

The dominance of LE did not last long, however. First, many of the internal problems of the movement, such as the issue of distinguishing neatly between meaningful and meaningless statements, stubbornly resisted a satisfying solution. Second, analytic philosophers such as Willard van Orman Quine (1908–2000) and Hilary Putnam (b. 1926) attacked the very basis of the logical empiricist philosophy of science, that is, the distinction between the synthetic/analytic and the observational/theoretical levels of empirical knowledge. Third, authors such as Norwood Russell Hanson (1924–1967) and Thomas Kuhn (1922–1996) shifted the emphasis from the strictly logical toward the historical and sociological aspects of scientific theorizing, thus challenging the autonomy of a logical philosophy of science in the style of Carnap.

In a sense these and related developments were welcomed as liberations from the straitjacket of the so-called "received view." For instance, one immediate consequence of the logical empiricist thesis that meaningful statements are either analytic or empirical was that all value judgments are cognitively meaningless. Value statements are not analytic because they say nothing about the world and are not empirical because they cannot be verified. Hence, they are meaningless. The dichotomy between analytic and empirical statements led logical empiricists to a strictly noncognitivist (emotivist) ethics according to which there can be no knowledge of values in a proper sense. This stance is not to be considered as necessarily leading to a loss of interest in moral and political problems. All members of the Vienna Circle took a strong interest in the political and social events they were living through. These problems, however, were considered as practical problems, to be strictly separated from the theoretical problems science and philosophy were dealing with.

This emotivist account of ethics, which leaves only a small niche for "theoretical meta-ethics," that is, the logical analysis of moral statements, is insufficient. In a world in which science and technology present increasing numbers of ethical questions and difficulties, it does not provide reasoned arguments formorally relevant actions.

At the same time the complete dismissal of LE by the self-proclaimed "revolutionary" postpositivist philosophy of science might have been a bit hasty, especially if one takes into account its lesser-known European variants. Indeed, the differences between LE and postpositivist philosophy of science might have been unfairly exaggerated. With regard to Neurath's and Hempel's versions of LE, it does not seem far-fetched to suggest that to some extent the allegedly unbridgeable gap between LE and its successors has been an interest-guided social construction. As usual, the critics of LE were unaware of how much they had absorbed of the belief system they so eagerly berated.

In summary, one may propose that LE was a rich philosophical movement that set the stage for a large part of the philosophy of science and epistemology during the twentieth century. However, despite this general claim, a balanced assessment of the movement has not been formulated. In particular, the relationships between LE and its successor disciplines, such as the various currents of "postpositivist" philosophy of science, cultural studies of science, and science, technology, and society studies (STS), are not yet fully appreciated.

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SEE ALSO *German Perspectives; Science, Technology, and Society Studies; Wittgenstein, Ludwig.*

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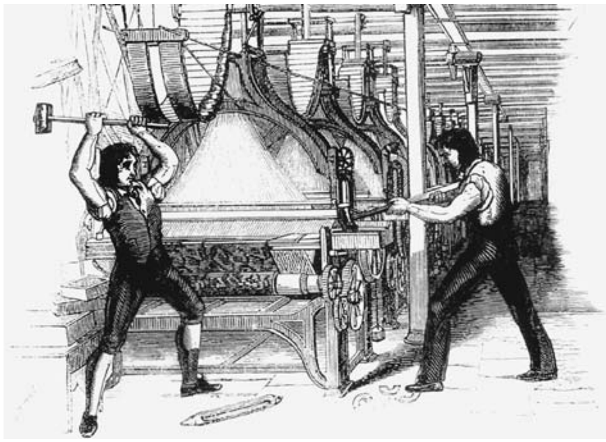
LUDDITES AND LUDDISM

Luddite and *Luddism* are terms of both derision and praise. Depending on context, they have been used to indicate either mindless opposition to or critical assessment of technology and science.

Origins

The first Luddites were English textile workers who in 1811 and 1812, during the Industrial Revolution, resisted and rebelled against the use of wide-frame knitting machines, shearing machines, and other machines of mass production. The term is based on a mythical Ned Ludd who supposedly led the workers in their resistance. The Luddites, however, were not one unified political group. They reflected their regions and local trade organizations, hence the more appropriate use of the terms Manchester, Yorkshire, and Midland Luddites.

Much of the knitting of stockings and other apparel was done in cottages and small shops by knitters (stockingers) who sometimes owned their own frames but usually rented them from the hosiers (the knitting-frame was invented by William Lee in 1589 and introduced in the Midlands in the mid-1600s). The knitting-frame, operated by an individual at home, could make 600 stitches per minute as opposed to about 100 stitches by



Depiction of the Luddite Rebellion. The rebellion began in 1811 when organized bands of men in England s Midlands began breaking into hosiery factories and smashing looms used to weave stockings. Claiming allegiance to "General Ludd," the Luddites were skilled craftsmen driven to despair by changes in weaving technology that cost them wages and worsened the effects of the already ongoing economic crisis. *(© Mary Evans/Thomas Philip Morgan.)*

hand-knitters. Frame-knitting in cottages sustained a way of life for more than a century.

The rebellion began in March 1811 in the Midland shire of Nottingham (home of the legendary Robin Hood) and then spread north to Manchester and Yorkshire. At the height of the rebellion, knitters, croppers, and other textile workers smashed textile machinery almost on a daily basis. The Midland Luddites were particularly well organized and led a sustained campaign of focused machine breaking without resorting to the more general violence evident in their northern counterparts. The open rebellion ended in 1812 with arrests and subsequent hangings.

The original Luddite rebellion grew out of intolerable economic and political conditions that threatened the livelihoods of the textile workers and eventually destroyed their cottage industry and their way of life. Economic factors included a depressed market resulting in part from Napoleon's economic blockade of British trade and Britain's counter-blockade of European ports. Wages decreased substantially at a time when a number of poor harvests in 1809 nearly doubled the price of bread.

Political conditions also fueled the rebellion. Fearful the French Revolution would spread to the working class, the Parliament passed the Combination Acts of 1799 and 1800 to outlaw trade unions and muzzle workers, making it a criminal offense for workers to join together to petition employers for fair wages and better working conditions. Furthermore the government's policy of non-intervention in industrial relations abandoned the working class to the captains of capitalist industry. In addition the Midland Luddites believed the acts of Parliament contravened the charter from King Charles II that founded the Framework Knitters' Company. In rebelling, the Midland frame-knitters upheld the principles of their charter to regulate their trade.

Historically Luddism may thus be described as an assertion of the right of organized trade to protect its way of life from the unfair introduction of technology, from technology that reduces the quality of the product, and from political measures that would change the trade without the consent of the trade workers.

Developments

Although the Romantic poet George Gordon Lord Byron (1788–1824) defended Luddites against their critics, by the mid-1800s the term had largely disappeared from use. Then in 1959 the novelist C. P. Snow in his famous lecture defending "The Two Cultures and the Scientific Revolution" revived it to stigmatize *literary intellectuals* such as T. S. Eliot and William Butler Yeats as *natural Luddites*. Following Snow, the term became a common way to disparage critics of the cultural influence of modern science as simply uninformed antitechnologists.

In the late-twentieth century, however, critics attempted to turn the tables on those who would dismiss them as technophobes by adopting the term *neo-Luddite* and *neo-Luddism* as a badge of honor for those who refuse to uncritically accept virtually everything that techno-economic momentum throws up. As Langdon Winner (1986) argued, technology critics are no more antitechnology than art and literature critics are anti-art and anti-literature. The most influential defense of this critical stance was perhaps Chellis Glendinning's "Notes Toward a Neo-Luddite Manifesto" (1990), which argued that technology and technological systems may be beneficial to global capitalism but are not necessarily beneficial to human beings, the environment, and the common good. Although neo-Luddism is not a well-defined creed, it commonly includes critiques of consumer culture, television, and high-energy use automobiles while promoting enhanced participation in technological design, social and economic equity, and respect for nature. Some representatives draw inspiration from religious traditions, especially Quakers, Mennonites, Amish, and Shakers. Others argue an inherent will to power in modern technology that threatens human dignity rather than enhancing it.

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SEE ALSO *Industrial Revolution; Modernization.*

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LUHMANN, NIKLAS

German sociologist Niklas Luhmann (1927–1998) was born in Lüneburg on December 6. In more than seventy books and 450 papers, he developed what is perhaps the most comprehensive theory of modern society, in which ethics plays an important, but secondary, role. Educated in legal science, Luhmann was inspired by the phenomenology of Edmund Husserl, the systems theory of Talcott Parsons, the theory of autopoiesis of Humberto Maturana, the second order cybernetics of Heinz von Foerster, and the form calculus of G. Spencer-Brown. He synthesized these elements into a systems theory of impressive scope and radicalism, representing what he saw as a paradigm shift in the social sciences. He died on November 6 in Bielefeld, Germany.

A Universal Systems Theory

Luhmann distinguished between physical, biological, mental, and social systems, but his main focus was on social systems, which he subdivided into interactions, organizations, and society as a whole. His main theoretical tool was the *distinction*. In order to observe social systems, the observer must use a *guiding distinction*. Luhmann chose the distinction between system and environment, but admitted that others were possible.

A radical tenet of Luhmann's systems theory is the thesis that social systems consist only of communication—not of persons, of artifacts, or even of actions. Communication is defined as the unity of three selections: information, utterance, and understanding, to which is added the acceptance or rejection of the receiver to continue the communication. Because communications are transient events, the system must generate linguistic structures and themes to create and combine new communications. Social systems are autopoietic systems, creating their own elements within their network of elements. Even though human beings, as information-processing units, are necessary for communication, they are not part of the communication, but of its environment. The physical world is likewise not part of the communication, but is only its object, and it is not the function of communication to mirror the physical world. By using the theory of autopoiesis, Luhmann made systems theory dynamic, with time and change at its center. Everything in a social system is contingent, meaning that alternatives are always possible.

According to Luhmann, social systems cannot be understood in terms of *rationality*, *norms*, or *human beings*. Change must be seen as evolution, a choice among existing alternatives. There is no one point of view from which society can be correctly observed and described. With the cultural death of God, and the attendant loss of the only ostensibly *right* worldview, a poly-centered world remains. In his late-twentieth-century analysis, Luhmann claims that the most fruitful way of imagining society is as a world community with no center, no purpose, and no overarching rationality.

Luhmann analyzes society as a unity of functional subsystems, each having is own symbolic generalized medium and its own guiding distinction. Society can be observed from many points of view, economic (where the medium is money), political (power), scientific (truth), intimate (love), and more. The number of functional subsystems is an empirical question. In addition to his two principal works, *Soziale Systeme* (1984) and *Die Gesellschaft der Gesellschaft* (1997), Luhmann wrote a series of monographs dealing with the various social subsystems.

Functional subsystems make communication more effective. By using symbolic generalized media, it is possible to communicate on a world scale because the simple binary form allows for simplification, motivation, and measurement of success or failure. An observer can quickly decide whether or not he will take over the point of view inherent in the medium. Symbolic generalized media can differ—in operation mode and time relations, among others—but all share a common structure. Though the most effective communications in modern society are oriented towards functional subsystems, Luhmann acknowledged that what is good for a functional subsystem is not necessarily good for society as a whole because proponents of each subsystem have biased and narrow views.

Technology can also be seen as a functional subsystem, operating in the medium of effectiveness. Its code is functioning or broken, its programs are blueprints, its institutions are organizations and universities, and its contribution to society is maintenance of regular processes. Technology has its own internal dynamics and thus it might clash with or be helpful to other functional subsystems.

Functional subsystems are not action systems. They *do* nothing, but can be conceived as semantic discourses. The action systems of twenty-first-century society are organizations; specialized organizations define themselves as agents of a particular functional subsystem, such as technology, religion, or law.

Morals and Ethics in Functional Subsystems

In real life, subsystems must cooperate. Because their respective criteria for success and failure are not the same, conflicts arise with no objective solution, thus creating a need for normative or ethical solutions. As a consequence, many functional subsystems develop special professional ethics criteria to deal with the integration of highly specialized products and methods in society.

It should be noted that no functional subsystem uses the moral distinction between right and wrong. One reason for this is empirical: A moral distinction is not precise enough to facilitate communication. It has too many dimensions. A moral evaluation might focus on motives or on consequences, and be dependent on religious or subcultural assumptions. Moralizing creates conflict, not consensus. Instead Luhmann views morality as a tool for distributing *esteem*, which depends not on professional skills but on the qualities of a person as a whole.

Morals have important social functions and Luhmann wrote extensively on moral issues though he flatly rejected any attempt to understand society in moral or purposive terms. Luhmann conceded that moral distinctions are used with the same spontaneity as empirical distinctions in daily life. Using the distinction between moral and ethics, he argued that ethics is a theoretical reflection of the social phenomenon of morals, and concluded that the most important task of ethics is to warn against morals. He had no illusions as to the effectiveness of ethics to control technological development. Because there is no ethical consensus in modern society, no ethical control is possible or desirable.

Each functional subsystem has its own criteria for success or failure, but it also has a tendency to exaggerate its own importance and blind itself to other criteria. Economy focuses on money, politics on power, and science on truth. When criteria clash, no super rationality can create a rational solution. Luhmann had a lifelong debate with the German philosopher Jürgen Habermas regarding this issue. Habermas stresses the possibility of rational consensus, while Luhmann argues that conflict is not only inevitable, but also fruitful. Consensus is only a transient phase in the ongoing communication of social systems.

Luhmann accepted that functional subsystems have evolved as centers for solving specific tasks, however, he argued the need for *criteria for criteria* or second order criteria. But such criteria, which might be called ethical criteria, are not socially binding. There is no universally accepted viewpoint from which the social and moral implications of technology or pollution, for example, can be observed and judged right or wrong.

Luhmann described each functional subsystem as having its own complexity and society as a whole as a hypercomplex entity composed of many functional subsystems. However Luhmann posited no solutions to the problems he presented. With no rationality, there is only evolution to rely on: Something will happen, perhaps better, perhaps worse, perhaps catastrophic. When nations, organizations and persons try to control technology, they are controlled by the technology they want to control and are unable to control all the other actors trying to control. Technology, like life, will find its way.

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SEE ALSO *German Perspectives; Habermas, Jürgen.*

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LYOTARD, JEAN-FRANÇOIS

French philosopher Jean-François Lyotard (1924–1998), who was born in Vincennes, France, on August 10, was an originator of what became known as postmodernism. After teaching philosophy in secondary schools in France and Algeria, Lyotard was awarded a position at the University of Paris VII, where he also served as a council member of the Collège international de philosophie. Toward the end of his life he also held visiting professorships in the United States. Lyotard died of leukemia in Paris on April 21.

Lyotard's work is marked by a persistent interest in the relations between science, technology, ethics, and politics, as can be seen in the work for which he is most well known, *The Postmodern Condition: A Report on Knowledge* (1984), which focuses on the state of knowledge in highly developed countries. According to Lyotard, the sciences and late twentieth-century societies were in the midst of a legitimation crisis because of the inability to provide a justification in the form of an overarching explanation of the relations between science, technology, and society.

Lyotard explains the crisis using Ludwig Wittgenstein's (1889–1951) notion of language games. A language game is a field of discourse defined by a set of internal rules that establish the types of allowable statements. Different discourse practices, such as science and ethics, have become distinct language games, adhering to different sets of rules. Because disparate language games prohibit statements that fail to conform to their rules, it is impossible to give a single, overarching account that would guarantee the legitimacy of all possible discourse practices. For this reason, Lyotard states that the postmodern situation is marked by an "incredulity toward meta-narratives" (Lyotard 1984, p. xxiv).

If Lyotard is correct and it is no longer permissible to give an overarching account for the diversity of discourse practices, then the postmodern condition demands a new response to the problem of legitimation. Lyotard claims that the appropriate response to the problem in a society marked by the postmodern condition is "paralogy." In the practice of paralogy, the goal of producing an overarching legitimation narrative is replaced by an attempt to increase the possible language moves in a particular language game. Hence, paralogy champions the diversity of discourse practices by prohibiting the hegemony of a single discourse over all others. Paralogy thus resists the tendency to treat ethics and politics as forms of scientific knowledge or technology.

The Postmodern Condition has implications for ethics that are further developed in *The Differend: Phrases in Dispute* (1988). A *différend* is Lyotard's label for an irresolvable conflict between two phrases or parties. The *différend* as a conflict between phrases was implied in Lyotard's earlier work as the inability to unify diverse language games. In this work, however, rather than being concerned with the legitimation of knowledge, Lyotard develops the notion of the *différend* to include a certain type of injustice that occurs to differing language games (or genres), specifically the cognitive and ethical.

The ethical genre, according to Lyotard, is concerned with prescriptive statements of the form "you ought," whereas the cognitive genre consists of descriptive statements. Ethics, with its prescriptive statements, is a discourse of obligation. As such, ethics takes the form of phrases marked by an asymmetry between the addressor and the person addressed. The person who says "You shall not lie" commands interlocutors and places obligations upon them, but the statement "Lying is wrong" leaves out the relation between persons that is characteristic of ethical discourse. Consequently for Lyotard, the nature of ethics is covered over in attempts to transform the prescriptive into the descriptive.

In response to this threat, the task of philosophy, according to Lyotard, is to champion and protect the diversity of discourse and practice. While not providing a unifying account of the relations between genres, philosophy is marked by an obligation to bear witness to the *différend*. Although primarily focused on discourse, this responsibility extends to the sociopolitical world, in which there is the continuous threat of one social entity (individual persons or cultures) being overpowered by another.

Lyotard's thinking continues to be a powerful, cautionary note for the relations between science, technology, and ethics. Rather than subsume distinct discourses under a unifying account, his work argues for maintaining that which marks each as different.

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SEE ALSO *French Perspectives; Postmodernism.*

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LYSENKO CASE

The debate on the relative influence of heredity and environment took a distinctive form in the Soviet Union in the turbulent years between the 1920s and the 1960s. There was among many committed communists a sense that the socialist revolution should transform everything, including the foundations of knowledge. There was intense debate about what constituted a Marxist approach to every discipline, including biology.

Lysenko's Practice and Theory

Into this context came Trofim Denisovich Lysenko (1898–1976), a young agronomist from the Ukraine, who emerged into the limelight in 1927 in connection with an experiment in the winter planting of peas to precede the cotton crop in the Transcaucasus. The results he achieved in a remote station in Azerbaijan were sensationalized in the national Communist Party newspaper *Pravda*. The article projected an image of him as a sullen, barefoot scientist close to his peasant roots. Lysenko subsequently became famous for *vernalization*, an agricultural technique that allowed winter crops to be obtained from summer planting by soaking and chilling the germinated seed for a determinate period of time. Lysenko then began to advance a theory to explain his technique. The underlying theme was the plasticity of the life cycle. Lysenko came to believe that the crucial factor in determining the length of the vegetation period in a plant was not its genetic constitution, but its interaction with its environment. By the mid-1930s he rejected the existence of genes and held that heredity was based on the interaction between the organism and its environment, through the internalization of external conditions. He recognized no distinction between genotype and phenotype.

Lysenko's theory was an intuitive rationalization of agronomic practice and a reflection of the ideological environment surrounding it rather than a response to a problem formulated in the scientific community and pursued according to rigorous scientific methods. Lysenko seemed to achieve results at a time when there was a great demand for immediate solutions and a growing impatience with the protracted and complicated methods employed by established scientists. This brought a sympathetic predisposition to whatever theoretical views Lysenko chose to express, no matter how vague or unsubstantiated.

Even Lysenko's practical achievements were extremely difficult to assess. His methods were lacking in rigor. His habit was to report only successes. His results were based on extremely small samples, inaccurate records, and the almost total absence of control groups. An early mistake in calculation, which caused comment among other specialists, made him extremely negative regarding the use of mathematics in science.

But Lysenko was the man of the hour, one who had come from humble origins under the revolution and who directed all his energies into the great tasks of socialist construction. He was pictured as the model scientist for the new era, and was credited with conscientiously bringing a massive increase in grain yield to the Soviet state, while geneticists idly speculated on eye color in fruit flies.

Genetics on the Defensive

Catching the ideological demagoguery that was beginning to flourish among a certain section of the young intelligentsia, some denounced the science of genetics as reactionary, bourgeois, idealist, and formalist, and contrary to the Marxist philosophy of dialectical materialism. Its stress on the relative stability of the gene was supposedly a denial of dialectical development as well as an assault on materialism. Its emphasis on internality was thought to be a rejection of the interconnectedness of every aspect of nature. Its notion of the randomness and indirectness of mutation was held to undercut both the determinism of natural processes and human abilities to shape nature in a purposeful way.

The new biology, with its emphasis on the inheritance of acquired characteristics and the consequent alterability of organisms through directed environmental change, was well suited to the extreme voluntarism that accompanied the accelerated efforts to industrialize and collectivize. The idea that the same sort of willfulness could be applied to nature itself was appealing to the mentality of those who believed that Soviet man could transform the world. Lysenko's voluntarist approach to experimental results and to the transformation of agriculture was the counterpart of Joseph Stalin's voluntarist approach to social processes, undoubtedly a factor in Stalin's enthusiastic support of Lysenko during this period.

Trofim Lysenko, kneeling in a field, measuring the growth of wheat. During the Soviet famines of the 1930s, Lysenko proposed techniques for the enhancement of crop yields, rejecting orthodox Mendelian genetics on the basis of unconfirmed experiments, and gained a large popular following. But in 1964 his doctrines were officially discredited, and intensive efforts were made toward reestablishing orthodox genetics in the Soviet Union. *(© Hulton-Deutsch Collection/Corbis.)*

Other political leaders and scientific administrators were not so easily swayed. Geneticists defended their work and had very influential support. There was strong resistance within the Academy of Sciences. The debate reached a climactic point at a special session of the Lenin Academy of the Agricultural Sciences in 1936, devoted to a discussion of the two trends in Soviet biology. The official goal was to achieve a reconciliation of the two schools, some kind of accommodation for genetics within the framework of Lysenko's agrobiology. The outcome was the opposite. The open confrontation of the two trends resulted in drawing the lines more sharply than ever and in highlighting the irreconcilability of the two contrasting approaches.

The sharpest speech in the defense of genetics came from the American geneticist Hermann J. Muller, a foreign member of the Academy of Sciences, who had come to work in the Soviet Union out of a belief in the possibilities of science under socialism. Muller was also inclined to philosophical reflection on science and had definite views as to the place of genetics within the framework of a dialectical materialist philosophy of science. He turned the charge of idealism against the Lysenkoites and accused them of hiding behind the screen of a falsely interpreted dialectical materialism.

The growing ascendancy of Lysenko coincided with the purges that reached into virtually every Soviet institution from 1936 to 1939. The campaign against geneticists became more and more vicious and slanderous. Scientific and philosophical arguments gave way to political ones. The pursuit of genetics was branded as racism and fascism. Geneticists were named and accused of sabotage, espionage, and terrorism. Many were arrested. Of these some were shot, while others died in prison. Still others were witch-hunted, lost their jobs, and were forced into other areas of work. Institutes were closed down. Journals ceased to publish. Books were removed from library shelves. Texts were revised. Names became unmentionable. The 7th International Congress of Genetics, which was scheduled to be held in Moscow in August 1937, was cancelled. When the congress did take place in Edinburgh in 1939, no Soviet scientists were present, not even the internationally respected geneticist N. I. Vavilov, who had been elected its president.

By 1938 Lysenko had been elected to the Academy of Science and replaced Vavilov as president of the Lenin Academy of Agricultural Sciences. In 1940 Vavilov was arrested and Lysenko replaced him as director of the Institute of Genetics of the Academy of Sciences. In 1941 Vavilov stood trial and was found guilty of sabotage in agriculture. After several months of incarceration, Vavilov's death sentence was commuted, but he died in prison in 1943 of malnutrition. Although some of the more outspoken and defiant survived, many gave way under the pressure, engaged in abasing self-criticism, and acknowledged the superior wisdom of Lysenko. The degree of demoralization was overwhelming.

Assessment

Lysenkoism reached its peak in 1948 with official Communist Party endorsement. But almost immediately after Stalin's death in 1953 it went into decline. Vavilov, for instance, was posthumously rehabilitated in 1955. However Lysenkoism continued to be a force in Maoist China, where a promotional congress was held in 1956. The case was thus a protracted episode in the history of science under Communism, and has been the subject of many commentaries.

These analyze the scientific, political and philosophical issues in quite divergent ways. Soyfer and others represent it as a story of personal opportunism and political terror, as a cautionary tale against the dangers of ideological distortion of science. This position tends to see philosophy and politics as alien impositions upon science. Joravsky, Graham and Lecourt put more emphasis on the complexity of the philosophical issues, although with varying degrees of hostility or sympathy with Marxism. Medvedev's account is of historical significance as a critique coming from someone within the world of Soviet science. Some searching and sophisticated explorations of the issues have come from within Marxism, most notably by Lewontin, Levins, and Young. This position is marked by an insistence that science is inextricatably tied to philosophy and politics, even to ideology, opening up a more nuanced investigation of the varying modes of interaction and a more complex critique of Lysenkoism.

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SEE ALSO *Communism; Russian Perspectives.*

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MACHIAVELLI, NICCOLÒ

Niccolò Machiavelli (1469–1527), born in Florence on May 3, was a Florentine statesman and Renaissance Italy's greatest political philosopher; he died in Florence on June 21. He is often regarded as the first to take a scientific approach to politics.

Niccolò Machiavelli, 1469–1527. Machiavelli was an Italian political philosopher during the Renaissance. His most famous book, *Il Principe,* was a work intended to be an instruction book for rulers. Published after his death, the book advocated the theory that whatever was expedient was necessary—an early example of utilitarianism and realpolitik. *(Corbis. Archivo Iconografico, S.A./Corbis.)*

Major Contributions to Political Thought

Machiavelli is known chiefly as the author of two books, *The Prince* and *The Discourses on Livy* (both c. 1517). The former concerns the acquisition of principalities, a form of government in which the state belongs to an individual or a family. The latter is a meditation on republics, in which the state is public rather than private property. The notoriety of these books is largely due to the absolute ruthlessness advocated by Machiavelli. In *The Prince,* he recommends acting against faith, charity, humanity, and religion. In *The Discourses,* he criticizes Giovampagolo Baglioni because that tyrant had the opportunity, but not the courage, to murder the Pope.

Despite their practical orientation, *The Prince* and *The Discourses* are works of political science. Machiavelli asks theoretical questions: how states are born and what sustains them. But his work marks a fundamental break with premodern political thought. Classical and medieval thinkers were concerned above all with the difference between good and bad forms of government; Machiavelli ignores that distinction in favor of hard realism. In the first chapter of *The Prince,* he classifies states solely according to how they are acquired. In chapter fifteen, he dismisses those who dream of imagined principalities; perhaps referring to heaven, or Plato's *Republic.* Machiavelli thus narrows the horizon of political science; the question is not what kind of government is best, but how do people get the kind they want.

To answer this question, Machiavelli first explains the origin of states. He observes that hereditary principalities are established based on habit: People accept the regime because they are accustomed to it. But every established government was once new. How does a new state survive long enough to *become* hereditary? Machiavelli ignores the traditional answers: God's blessing or natural development. Perhaps just dumb luck? But fortune is fickle by definition, and does not sustain any one thing for long. Because all states originated from some source, Machiavelli proposes that certain people have, within themselves, the power to conquer fortune, to create armies, and to establish and maintain states.

He calls this power *virtue,* a word suggesting the premodern idea of moral excellence. But in fact, Machiavelli's definition of virtue supports the ruthlessness he advocates. Morality and justice as commonly understood exist only as the products of established states. Machiavellian virtue must exist before the state is founded, and is therefore beyond ordinary right and wrong. It does, however, require that certain temptations be resisted: The prince must never rely on fortune or the grace of others, or put off until tomorrow a murder he needs to commit today.

Whereas ancient philosophers were conservative, more concerned with preserving decent governments than with creating new ones, Machiavelli encourages innovators. He especially admires those who create principalities and republics from scratch, or rejuvenate existing ones. In all cases, he insists that the innovator must rely on his own virtue, and have *arms of his own.* By this, Machiavelli means soldiers, loyal to the prince alone. He severely criticized Italian states for their reliance on mercenary and *auxiliary* arms. Paid soldiers, or those borrowed from another prince, have no connection to the innovator's virtue, and so cannot be a secure foundation for the state.

Pertinence to Modern Political Thinking

Machiavelli is regarded by some as the founder of value-free political science. He describes politics as it is, not as it might be, and shows how this knowledge can be exploited to bring greater order into human affairs. But Machiavelli's science is anything but value-free: He prefers glory to security, and admires innovators more than conservatives. Though he writes both for republics and tyrants, many have argued that he favors one over the other. In fact, he clearly has a preference for republics, but believes that the founding father of every republic needs to possess unrestrained power.

Machiavelli's writing has never gone out of fashion. Perhaps this is because he had the courage to face certain hard truths about modern thought. In order to conquer chance and nature, the early moderns were willing to reject the authority both of divine and natural right, thus imposing no moral restraints on the technological power unleashed by their new sciences. Machiavelli's political science vividly illustrates the consequences of their boldness.

Machiavelli paid relatively little attention to the rise of modern science and technology, concentrating much more on the topic of political reform. It was left to Francis Bacon and others to apply Machiavellian principles to the conquest of nature as a whole. But Machiavelli's thought did at least hint at the Baconian project. He speculates that it was natural famine that drove large populations of barbarians out of their homelands in the east to inundate the Roman empire. He likens the movement of such peoples to floods, and speaks of strong political institutions as dams and dikes that can restrain such floods. Machiavelli is thus developing a science of politics that is technological in the modern sense.

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SEE ALSO *Modernization; Scientific Revolution.*

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MANAGEMENT

OVERVIEW

The term *management* can name both an activity and persons in charge of the activity. As activity, the term derives from the Italian *maneggiare*, meaning to handle or control a horse, which is itself rooted in the Latin *manus*, or hand. In the late 1500s the word was applied to the governing body of a theater and from there to other business activities, including those involved with industrial manufacture. Shifts in the ownership of large-scale manufacturing companies led to what has been termed a managerial revolution, in which direct control and decision-making became invested in neither owning capitalists nor wage-earning workers but in salaried managers (Burnham 1941, Chandler 1977). This shift has influenced both science and technology, with "big science" and "technoscience" increasingly managed by neither science nor engineering workers—a development that poses questions of ethical responsibility for both technical professionals and managers. Attempts to systematize informal management techniques into either a science or a technology of management further highlight ethical issues.

Historical Background

Humans have always collaborated to reach shared goals. Distributed tasks for common ends require coordination, planning, control, and organization—all of which are as subject to ethical assessment along with the ends to which they are subordinate. For example, in Plato (c. 428–347 B.C.E.) one can find both praise for the division of labor that engenders expertise in specialized workers (*Republic*) and criticisms of the pretensions of technical specialization (*Apology* and *Gorgias*). Thus, although the term did not exist as such, "management" has often been read back into such preindustrial orders of household, tribe, city-state, military, or church. What distinguishes modern management from traditional political or religious organization and leadership is its greater emphasis on the systematic coordination of means.

Management did not take on its contemporary connotations until the technological, economic, political, and social changes of the Industrial Revolution (c. 1750–1850). Specifically, certain organizational problems arose in the embryonic factory system that led to the genesis of modern management practices and eventually the formalization of management study (Wren 2005). It was also during this era that attitudes to work began to change, although slowly, from ceaseless, futile labor to opportunities for personal wealth and social progress. Central to this transformation were the Renaissance revival of science and reason and the Protestant work ethic with its notion of a worldly "calling" that Max Weber (1930) argued paved the way for market-based capitalist economies.

The modern understanding of management in terms of leading an organization toward a goal through the deployment and manipulation of resources (material, human, financial, and intellectual) was further shaped by classical and nineteenth-century economic theory and the development of technical production elements such as standardization, specialization, and work planning. The emergence of modern technologies and the market economy challenged managers to develop a body of knowledge on how best to administer and utilize human and technological resources. By the middle of the nineteenth century, Robert Owen (1771–1858) and others were developing theories pertaining to the human element of management including worker training, organizational structure, span of control, and the effects of fatigue on performance. By the 1880s, university courses in management were being offered, based in part on the work of Andrew Ure (1778–1857), who developed training programs for managers in the early factory system.

The first comprehensive theories of management appeared around 1920 in the work of scholars such as Henri Fayol (1841–1925), who outlined five functions for managers and synthesized fourteen principles for organizational design and effective administration. Some theorists such as Ordway Tead (1891–1973) applied principles of psychology to management, whereas Elton Mayo (1880–1949) and others approached it from a sociological perspective. In *The Practice of Management* (1954), Peter F. Drucker (b. 1909) presents a contrast to the Fayolian process texts by introducing the notion of "management by objectives," which replaces control from above with self-control and greater worker empowerment in the goal of reaching well-defined objectives.

In *The Managerial Revolution* (1941), James Burnham (1905–1987) sets management theory within a broad historical narrative of political economy and technological change. Burnham saw industrial production coming to be controlled neither by the owners (capitalism) nor the working class (socialism). Rather, a new managerial class was replacing the bourgeois capitalist as a dominant social force, as ever more complex systems of production separated control from ownership. For Burnham, technological progress necessitates a hierarchy of managers among whom direction and coordination of production becomes a highly specialized skill.

In *The Visible Hand* (1977), Alfred D. Chandler Jr. (b. 1918) presents a similar argument but one less oriented toward prophecy. Chandler claims that neither the traditional family firm nor market mechanisms are able to coordinate the increasingly swift and complex flows of goods made possible by technological innovation. Managers of large, multiunit businesses fill this need for coordination, and in so doing assume strong economic and social power, giving rise to managerial capitalism: "In many sectors of the economy the visible hand of management replaced what Adam Smith referred to as the invisible hand of market forces" (p. 1). But while acknowledging the centrality of technology in bringing about increased managerial control, Chandler fails to explore fully the role of scientists and engineers.

The managerial revolution may have held true in heavy industry, but it seems less valid for service and information economies, where bigger and more complex is not always better. Indeed the continual evolution of technological, political, and economic contexts ensures that management theories are constantly being revised. Some of the more recent developments in management thought include operations research, the theory of constraints, reengineering, complexity theory, and information technology–driven theories. A general trend in management thought is toward systems-based, adaptive processes capable of integrating several categories (e.g. human resources, marketing, and production) into a complex, flexible web of organizational administration.

Management as Science

The conceptualizing and ordering of management as a science did not begin in earnest until the nineteenth century. And although Charles Babbage (1792–1871) made significant contributions to management science, Frederick Winslow Taylor (1856–1915) is viewed as the founder of the field. In 1895 Taylor wrote a seminal paper titled "A Piece-Rate System" that developed a set of management techniques designed to stimulate maximum worker productivity and efficiency. This helped fuel the rising emphasis on efficiency and rationality in decision-making that sought the "one best way." Theodore Roosevelt, Gifford Pinchot, and other conservationists spearheaded this movement by preaching a "gospel of efficiency" in natural resource management, which was "an attempt to supplant conflict with a 'scientific' approach to social and economic questions" (Hays 1959, pp. 266–267).

In *The Principles of Scientific Management* (1985 [1911]), Taylor acknowledged the inefficiencies in natural resource use, but argued that wasteful practices in human resource management were just as damaging to the goals of efficiency, productivity, and prosperity. The Industrial Revolution had vastly increased resources and capital and improved technologies, but crude ways of organizing and administering these resources hampered productivity. Taylor set out to prove that the best management is a true science, resting upon a clearly defined foundation of laws, rules, and principles. Furthermore, he sought to show that the fundamental principles of scientific management are applicable to all kinds of human activities, from the simplest individual acts to the work of huge corporations.

Among other organizational techniques, this "true science" involved standardizing measures of productivity and quality; developing time, motion, and method studies; and improving the relationship between mangers and workers. In one instance, Taylor was able to reduce the number of people shoveling coal at Bethlehem Steel Works from 500 to 140 by designing more ergonomic shovels. Taylor believed the credo of rational efficiency would lead to prosperity for all, thus abolishing class hatred, but many labor leaders felt that scientific management meant autocracy in the workplace. In fact, Taylor was questioned at length by Congress in 1911 and 1912 on the grounds that some of his methods treated workers like machines.

Frank Gilbreth (1868–1924) and Lillian Gilbreth (1878–1972) were associates of Taylor, and their studies culminated in laws of human motion from which evolved principles of motion economy. The Gilbreths coined the term *motion study* and used cameras to record motions and improve efficiencies even in domestic chores. Other important pioneers in scientific management included Henry Gantt (1861–1919) and Charles Bedaux (1886–1944). After World War II, scientific management played a key role in boosting economic productivity. Statistical and mathematical techniques were applied to planning and decision analyses. Physics Nobel laureate Patrick Blackett (1897–1974) combined these techniques with microeconomic theory to produce the science of operations research, which has been greatly enhanced by the use of computers.

The work of social scientists such as Elton Mayo uncovered many aspects of human interaction in the workplace that had been ignored by other theorists. Specifically, he noted that worker motivations (e.g., feelings, multiple needs, personal goals) are often outside the bounds of the logical, rational human being posited by scientific management, and that workers think and act not as individuals but as members of formal or informal groups (see also McGregor 1960). This type of work led to the rise of human relations management. The period between 1950 and 1970 witnessed a sevenfold increase in managerial employment. It was during this time that behavioral science became widely applied to management practices by theorists such as Rensis Likert (1903–1981). There is a wide range of contemporary scientific theories of management, and it is clear that the best fit for improving performance depends in part on contextual contingencies.

Indeed in many areas alternatives and complements to scientific management stress the importance of building flexibility into systems in order to accommodate the surprises generated by nature, cognitive limitations, and the pace of global commerce. One example is adaptive management (e.g., Brunner et al. 2005), which is a diverse field developed in the 1970s and based on the incorporation of multiple stakeholders in decision-making processes in order to shift to bottom-up, open-ended management structures. In natural resource management, the underlying realization is that the politics of most problems (even many highly technical ones) cannot be elided by focusing solely on scientific expertise and efficiency. In the business world, the driving factors in the shift away from overly rigid forms of scientific management are the need for flexibility to maintain competitiveness and the realization that many valued outcomes are not readily captured by quantification.

Thus scientific management has from its beginnings been a diverse field that has given rise to equally diverse criticisms. It has been both praised and stigmatized as technocratic, insofar as technocracy can be conceived as an ideological-free pursuit of efficient production and a form of production that excludes the consideration of human values. In natural resource policies, technical management has been argued to impede common-interest solutions (Brunner et al. 2005). In business, although it can lead to greater competitiveness via increased efficiency, scientific management can also rigidify an organization, robbing it of flexibility and creativity.

More generally, Alasdair MacIntyre (1984) criticizes the notion of managerial expertise that derives from the dominant conception of the social sciences as somehow mimicking the natural sciences. For MacIntyre, "What managerial expertise requires for its vindication is a justified conception of social science as providing a stock of law-like generalizations with strong predictive power" (p. 88). He then identifies four sources of systematic unpredictability in human affairs, which he claims undermine the very notion of managerial expertise. He concludes that the concept of managerial expertise, or the idea that anyone can consciously manipulate the social order, is a moral fiction: "Our social order is in a very literal sense out of our, and indeed anyone's, control" (p. 107). What appears to be pragmatic, scientifically managed social control is but the skillful imitation of such control. This does not deny the enormous power exercised by bureaucratic managers, it is just that "the most effective bureaucrat is the best actor" (p. 107).

Nevertheless, regardless of outcomes and the fact that the term has fallen out of use, "'scientific management,' as well as its near synonym, 'Taylorism,' have been absorbed into the living tissue of American life" (Kanigel 1997, p. 6). Indeed, the history of scientific management mirrors the development of science more broadly, having evolved from the ideal of disclosing a single right answer to the reality of uncovering an imbroglio of human values intertwined with artifacts and systems, in which uncertainty and ambiguity are multiplied along with the importance of context and values.

Management as Technology

Parallel with attempts to develop management as a science—and as a science with applications—have been attempts to conceptualize management as a technology. Here the leading theorist has been Peter Drucker, who argues for an identification between management and modern technology. Just as in premodern technology work was more important than the tools with which work was performed—that is, work is the context from which tools receive their meaning—so in modern technology management or the organization of activity is the whole that unifies material resources, human labor, financial capital, and machines. Central to any wealth production is the process of ordering, interrelating, or managing the parts in order to assemble a productive business enterprise, which Drucker identifies as a "*system* of the highest order" (1970, p. 55).

For Drucker, management as technology may also be understood as an extension of biological evolution. Management is an adaptive process that orders (and reorders) different aspects of the world (through productive work); as such management is the most general contemporary expression of the human capacity for purposeful, nonorganic evolution. Tools and technologies are not just givens for management but, like the materials and human beings who make up a productive enterprise, are able to be transformed by management—and then transformed again in response to the changed context that the original transformation produces. Management involves a recursive process in which it takes its own successes and failures into account. "The organization of work, in other words, is . . . the major means of that purposeful and nonorganic evolution which is specifically human" (pp. 48–49).

Related to Drucker's view of management as technology is an argument by intellectual historian Bruce Mazlish (1993) regarding the relation between humans and machines. For Mazlish modern history is characterized by the rejection of four discontinuities: between Earth and the rest of the cosmos (Newtonian mechanics, which used the same laws to explain terrestrial and planetary phenomena), between animals and humans (Darwinian evolution, which argued for a natural development from animals to humans), between the unconscious and rationality (Freudian psychology, which presented reason as tied to the unconscious), and between machines and humans (through the integration of computers and humans). By arguing that human beings are defined by their coevolution with machines, a coevolution they must learn to manage, Mazlish likewise presents management (without using the term) as the fulfillment of technology.

Insofar as this is the case, of course, the science and technology of management must also be brought to bear on science and technology, especially big science or technoscience, which has become a complex enterprise. As first identified by the historian of science Derek J. de Solla Price (1963) and scientist-science administrator Alvin M. Weinberg (1967), science that depends on large-scale funding and coordinates many disciplines to achieve a common goal (such as the Manhattan Project to create the atomic bomb) requires increasingly sophisticated techniques of management. The same goes for macroengineering projects such as the U.S. interstate highway system or the European Channel Tunnel (or Chunnel). When this is the case it can reasonably be argued that the science and technology involved have become manifestations of management.

Management Ethics and Policy

In an influential analysis of how theories of human nature influence managerial practice, Douglas McGregor observed that "the more professional the manager becomes in his use of scientific knowledge, the more professional he must become in his sensitivity to ethical values" (1960, p. 12). Indeed, professionals can expect to be granted professional autonomy by the societies in which they operate only "to the extent that human values are preserved and protected" (p. 14). As the prominence of scientific and technological management has increased, so has the question of the relation between management and ethics—both ethics in management and the management of ethics.

In many instances management ethics is not strongly distinguished from business ethics. As in business ethics, key issues in management ethics include standards of communication, conflict of interest, responsibilities to stockholders, treatment of employees, social and environmental responsibilities, leadership obligations, and more. But because of their managerial roles, managers more than businesspersons or entrepreneurs also have to deal with the ethics of introducing ethics into business operations. One of the central issues in management ethics is thus how to introduce and manage ethics in a corporation or other enterprise that is also being managed for shareholder profit and/or stakeholder interests. One of the key questions for management ethics is thus: What is the proper role for ethics in management? Given the practical orientation of management, this includes: How is ethics best managed?

With regard to managing science and technology, the distinctive forms of scientific research and technological development organizations and processes must also be taken into account. Claude Gelès and colleagues (2000), for instance, argue that because most management texts assume a context of traditional business organizations using repetitive tasks and mass production to make a profit, they are not relevant to the management of scientific laboratories that use exploratory research and creativity to produce new knowledge and technical innovation. To achieve their aim of managing innovation to produce more innovation, science and technology managers need to be aware of the special characters of scientists and engineers, and of institutional resistances to new knowledge and technical innovation. They also need to be aware of the special ethical challenges involved in the scientific production of knowledge associated with temptations to scientific misconduct and the need to promote best practices in the responsible conduct of research.

Finally, because management takes place largely by means of establishing policies, the management of science is intimately related to science policy, especially that type of science policy known as policy for science. Here the work of Weinberg, as a reflective scientist manager of a big science and technology organization (Oak Ridge National Laboratory), provides basic orientation. For Weinberg, it is useful to distinguish internal and external criteria for decision-making in the management of science. Internal criteria focus on whether a particular research program is ripe for pursuit and on the competencies of the scientists involved. External criteria are of three types: scientific merit, technological merit, and social merit. Finally, Weinberg argues that especially in big science, which depends for its existence on financial support from the larger non-scientific community, and because science cannot be presumed to be the summum bonum (supreme good) of a society, "the most valid criteria for assessing scientific fields come from without rather than from within the scientific discipline" (1967, p. 82).

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SEE ALSO *Business Ethics; Science Policy; Science, Technology, and Society Studies; Work.*

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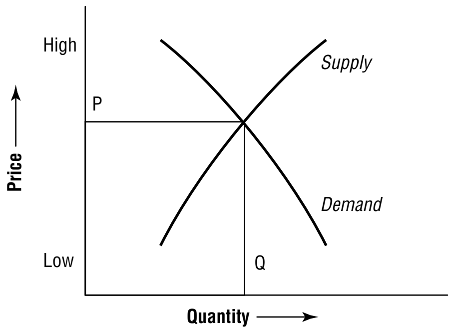
MODELS OF

Management is the process of reaching individual and collective goals by working with and through human and nonhuman resources to improve the world. Managerial values include performance effectiveness (achieving goals), operational efficiency (not wasting resources in the process), sustainable innovation (continually improving outputs and processes), and adding value (as measured by stakeholder responsiveness). Good managers demonstrate sound judgment by balancing these four competing but complementary values.

The four values inherent to some degree at all levels of management are embodied in four management mod-

FIGURE 1

Market Clearing Price



SOURCE: Courtesy of Joseph A. Petrick.

els. Those models focus on rational goals, internal process, human relations, and open systems (Quinn et al. 1995), each of which involves ethical issues that have relevance for the management of science and technology.

Rational Goal Model

The rational goal model, which Frederick Taylor (1856–1915) introduced at the beginning of the twentieth century, stresses the importance of managerial external control that results from the exercise of director and producer role responsibilities in order to employ humans and other tools to engineer optimal productivity (Taylor 1911). Performance effectiveness is achieved through setting goals, speeding productivity, and increasing profits faster than external competitors can and by using time-and-motion studies, financial incentives, and technological power to maximize output.

Three of Taylor's followers—Henry Gantt (1861–1919) and Frank (1868–1924) and Lillian (1878–1972) Gilbreth—expanded the rational goal approach by using new engineering techniques (time and motion studies) that enhanced the ability of technological experts to expand productivity. Time and motion studies provided detailed information about job activities such as grasping, searching, transporting, or assembling and the time it took to complete them in order to measure normal and superior productivity standards.

The strength of this model is that it accounts for managers' providing structure and initiating action. The exclusive and extreme emphasis on the rational goal model, however, imposes fast-paced, robotlike movements on people that were impossible to sustain, and this neglect of individual psychosocial needs in the pursuit of economic returns tends to result in offended individuals and destroy cohesion at the organizational level.

At the microeconomic and geopolitical levels the rational goal model of management was advanced indirectly by Alfred Marshall (1842—1924) and James Burnham (1905—1987), respectively. Marshall was a neoclassical economist who explained how the price and output of a good are determined by both supply and demand curves, such as the price and output of new automobiles that are determined by the demand of the buyers and the supply from the manufacturers, that are like scissor blades that intersect at an optimal point of equilibrium. It is at this point of equilibrium that buyers, sellers, and/or managers could and should rationally optimize their utility values by clearing the external market (see Figure 1).

Burnham's later neoconservative geopolitical works argue that because of the unceasing desire for power among an oligarchy of managerial elites from the three major global "super-states," the struggle for external political control of the world requires a decisive victory by strong-willed U.S. political leadership that exercises an aggressive geopolitical strategy by using all the offensive resources at its disposal. The perceived overreliance on the rational goal model at the microeconomic and geopolitical levels to secure external global control has led to the expected results of offended stakeholders and has destroyed cohesion at those extraorganizational levels as well.

Internal Process Model

The internal process model introduced by Henri Fayol (1841–1925) in the first quarter of the twentieth century stresses the importance of managerial internal control that results from the exercise of the monitor and coordinator role responsibilities in order to exert authority over humans to maintain the stability of hierarchic administration. Operational efficiency is achieved through information management, documentation control, and consolidated continuity and by emphasizing process measurement, smooth functioning of organizational operations, and the maintenance of structural order (Fayol 1916). Fayol described the five functions of management as planning, organizing, commanding, coordinating, and controlling and laid down fourteen principles of good administration, with the most important elements being specialization of labor, unity and chain of command, and the routine exercise of authority to ensure internal control.

Another key exponent of operational efficiency in managing large groups was the sociologist Max Weber (1864–1920), who described and advocated the indispensability of bureaucracy. Weber's ideal bureaucracy included authority, hierarchy, formal rules and regulations, and impersonality in rule application. His ideal bureaucrat neutrally and efficiently manages by the book and follows orders from above even if they go against his or her personal convictions.

When the internal process model is applied to politico-economic control, socialist and communist regulatory infrastructures constrain the negative externalities of the free market but create the risk of stifling technological and politico-economic innovations through overregulation. The strength of this model is that it accounts for managers' maintaining structure and collecting information. The exclusive and extreme emphasis on the internal process model, however, results in stifled progress and neglected possibilities at the organizational and extraorganizational levels.

Human Relations Model

The human relations model, which Elton Mayo (1880–1949) popularized in the second quarter of the twentieth century, stresses the importance of the managerial internal flexibility that results from the exercise of facilitator and mentor role responsibilities in order to improve human relations at work and enhance extraorganizational stakeholder responsiveness. Stakeholder responsiveness is achieved by showing managerial consideration for employees' psychosocial needs to belong, fostering informal group collaboration, and providing recognition at work as well as promoting managerial social responsibility and humane community building in society (Mayo 1933). Mayo's research at the Hawthorne Works demonstrated that management consideration, employee group affiliation, and special recognition motivated can increase productivity.

Peter Drucker (1909–2005), although critical of Mayo's perceived psychological manipulation of employee loyalty, promotes the value of the socially responsible use of managerial power and humane community building. He argues that in a global knowledge society managerial power can and should be applied to the nonprofit sector because that appears to be the primary sector that is focusing on creating socially responsible citizens and giving knowledge workers a sphere in which they can make a positive difference and re-create meaningful communities.

The strength of this model is that it accounts for managers' showing consideration and facilitating supportive interaction with intraorganizational and extraorganizational stakeholders. The exclusive and extreme emphasis on the human relations model, however, creates the risk of slowing production at work and abdicating decision-making authority in society.

Open Systems Model

The open systems model introduced by Paul Lawrence (b. 1933) and Jay Lorsch (b. 1934) in the third quarter of the twentieth century stresses the importance of the managerial external flexibility that results from exercising the innovator and broker role responsibilities in order to adapt continually to changing environmental forces (Lawrence and Lorsch 1967). Sustainable innovation is achieved by cultivating organizational learning cultures, developing cross-functional organizational competencies for continuous creativity, and respecting quality and ecological system limits while negotiating for external resource acquisition, building sustainable entrepreneurial networks, and enabling creative system improvement.

W. Edwards Deming (1900–1993) used statistical quality control to separate special and common causes of variation, fixing the former and accepting the latter to improve production systems continually by narrowing the range of acceptable performance variation over time. Deming's message to managers was that because most performance variations are the result of common causes, that is, fall within a normal range of statistical variation, managers should focus on improving the production system instead of overcontrolling employees.

Paul Shrivastava (b. 1939) focuses on entrepreneurial ecocentric management of sustainable development systems that technologically prevent and/or control pollution of nature and corruption of sociopolitical systems over time. The strength of this model is that it accounts for managers' envisioning improvements and acquiring resources for sustainable system development. The exclusive and extreme emphasis on the open systems model, however, results in disrupted operational continuity and energy wasted on unrealistic change projects.

Ethics of Management

The four management models for handling behavioral complexity have management ethics parallels in handling moral complexity, that is, inclusively balancing the competing moral values of achieving good results, following the right rules, cultivating a virtuous character, and creating supportive contexts (Petrick and Quinn 1997). In effect, the way people manage—make managerial judgments—implicitly and/or explicitly discloses their moral value priorities: the relative emphases they place on results, rules, character, or context in their moral choices. Rational goal "bottom line" managers are naturally disposed to emphasize results-oriented teleological ethics theories; internal process "by the book" managers are naturally disposed to emphasize rule-oriented deontological ethics theories; human relations "bleeding heart" managers are naturally disposed to emphasize character-oriented virtue ethics theories; and open systems "change agent" managers are naturally disposed to emphasize context-oriented situation ethics theories. Nevertheless, just as the balance and inclusiveness of the four management models determine the quality of managerial behavioral complexity judgment, the balance and inclusiveness of the four ethics theories determine the quality of managerial moral complexity judgment as well.

Especially in bringing these ethical issues to bear in the management of science and technology, the economist Adam Smith's (1723–1790) social calculus of adding individual selfish motives to the greater good must be supplemented by the insight that managers often are faced with ethical responsibilities that run counter to their actual or perceived self-interest. Otherwise, management ethics would be synonymous with corporate profit or self-promotion. A case in point would be the uncritical scientific endorsement of genetically modified human foods for global profit without morally considering the harmful effects of genetically modified foods on the health of current and future human generations.

Management ethics involves a complex and inclusive balancing of multiple stakeholder interests, internal and external to organizations, domestically and globally. For example, business managers that focus only on advancing the financial interests of investors while neglecting other stakeholders' interests, such as those of employees, society, and nature, are increasingly criticized for an unduly narrow and short-term managerial ethics perspective. The ability to simultaneously and/or sequentially optimize moral results, rules, character, and context in a sustained way for multiple stakeholders at intraorganizational and extraorganizational levels is becoming the touchstone of sound management ethics and the basis of hope for moral progress in the future.

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SEE ALSO *Bureaucracy; Engineering Ethics: Overview; Entrepreneurism; Stakeholders; Work.*

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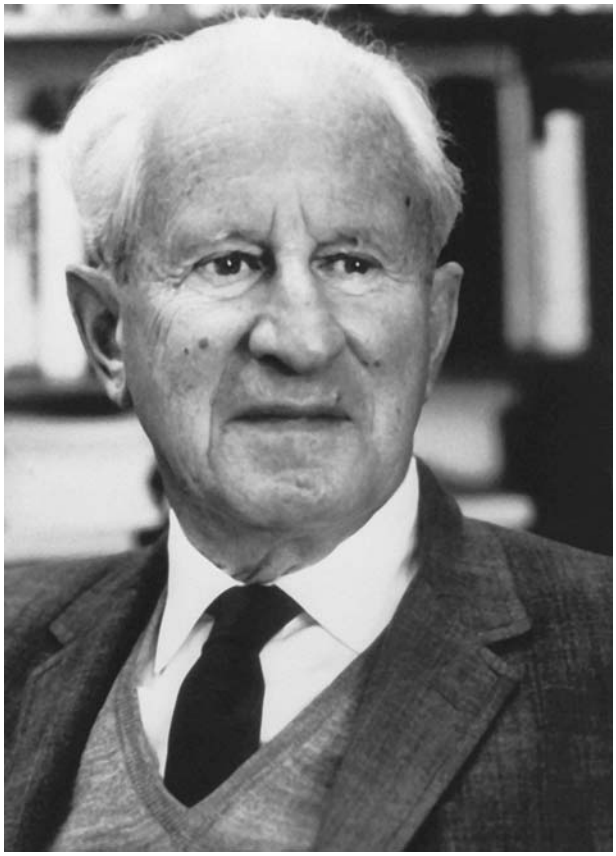
MARCUSE, HERBERT

Herbert Marcuse (1898–1979) was born in Berlin on July 19. After earning a doctorate in literature in 1922, he studied philosophy with Martin Heidegger (1889–1976) in Freiburg from 1928 to 1933. Troubled by Heidegger's affiliation with the National Socialist party, Marcuse joined the philosophers Max Horkheimer (1895–1973) and Theodore Adorno (1903–1969) at the Institute for Social Research in Frankfurt before fleeing to New York in 1934. Marcuse remained for the rest of his life in the United States, where he continued the institute's interdisciplinary work in critical social theory. He died on July 29 in Starnberg, after having suffered a stroke on a trip to Germany. Marcuse synthesized the works of Heidegger, Karl Marx (1818–1883), and Sigmund Freud (1856–1939) into a unique philosophical perspective from which he analyzed the nature of social control and the prospects for liberation in advanced industrial capitalist and communist societies.

Among Marcuse's contributions to critical social theory was his analysis of science and technology as instruments of social and political domination. Echoing Heidegger, Marcuse spoke of the "technological a priori" of scientific-technical rationality that projects nature as potential instrumentality. Technological rationality homogenizes people and nature into neutral objects of manipulation. That rationality is easily co-opted by economic and political power. However, science and technology merely function in the service of social control; they could be transformed to serve different ends, such as freedom, individuality, and creativity.

Marcuse's 1941 article "Some Social Implications of Modern Technology" argued that technological rationality undermines traditional "individual rationality" (autonomy) by employing efficiency as the single standard of judgment. Industrialized societies take advantage of the notion of efficiency to induce people to accept mass production, mechanization, standardization, and bureaucracy. Consequently, Marcuse argued, appeals to enlightened self-interest and autonomy appear progressively quaint and irrational in the face of a technological rationality that makes conformity seem reasonable and protest seem unreasonable.

In the mid-twentieth century political power—including state capitalism, fascism, and state socialism—developed seemingly rational, even pleasurable, means of social control that integrated individuals into a homogeneous society. The result was a "one-dimensional" society that eroded the capacity for individuality, critical thinking, and practical resistance. However, Marcuse maintained that the same impersonal rationality that made individualism unnecessary could be harnessed to realize rather than repress human capacities. Technological rationality could be used as an instrument to foster democracy, autonomy, and individuality. Marcuse was pessimistic about the prospects for that transformation because the technological apparatus tends to incorporate and subsume all opposition. However, despite Marcuse's pessimism regarding the achievement of such a transformation, he maintained that it was in principle possible.



Herbert Marcuse, 1898–1979. Marcuse was a leading 20th-century New Left philosopher in the United States and a follower of Karl Marx. His writing reflected a discontent with modern society and technology and their "destructive" influences, as well as the necessity of revolution. He was considered by some to be a philosopher of the sexual revolution. *(© UPI/Corbis-Bettmann.)*

In his most influential book, *One-Dimensional Man* (1964), Marcuse continued to argue that advanced industrialized societies employ science and technology to serve existing systems of production and consumption but claimed that technological rationality itself required transformation; it could not remain value-neutral if it were to lead to real human liberation. Marcuse also extended his analysis of the role of science and technology in manipulating human needs through advertising, marketing, and mass media. The scientific and technical aspects of a society are used to increase productivity and dominate humans and nature. The result is a carefully managed society that creates a one-dimensional person who willingly conforms to a society that limits freedom, imposes false needs, stifles creativity, and co-opts all resistance.

At the end of *One-Dimensional Man* Marcuse expresses the hope that humans one day will develop technologies for the "pacification of the struggle for existence" that will reduce misery and suffering and promote peace and happiness. Developing those technologies would require a political reversal, not simply more technological advances. A radical break from existing capitalist modes of production is needed to generate a new science and new technology. Science and technology then would become the instruments of liberation, not domination. New technologies would lead to new modes of cooperative production, energy sources, management, and communities; a new science of liberation would serve the interests of freedom and help satisfy genuine human needs. In his later work Marcuse considered the contributions that utopianism, student revolts, feminism, and aesthetic interests might make to the emergence of a new science and technology.

Marcuse was enormously popular in the 1960s and 1970s, and although his fame has been eclipsed since that time by that of Jürgen Habermas (b. 1929) and

French postmodern thinkers, he left an enduring legacy in critical social theory. He created a widely influential framework for analyzing the connections among political economy, science, technology, mass media, and culture in a way that not only identifies social domination and oppression but also attempts to identify the potential for social transformation leading to human liberation.

DAVID M. KAPLAN

SEE ALSO *Critical Social Theory; Habermas, Jürgen.*

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MARKETING

SEE Advertising, Marketing, and Public Relations.

MARKET THEORY

The market system allows individuals to exchange goods and services voluntarily, based on prices, without knowing one another. For instance, the cup of coffee a person drinks in the morning was brought to that person by thousands of strangers, who cultivated, harvested, processed, manufactured, packaged, shipped, stocked, and sold goods at various stages of production along the way.

One way to appreciate the distinctiveness of market-mediated trade among strangers is to contrast it with other ways in which people transact with one another. The anthropologist Alan Fiske (2004) suggests that all interpersonal transactions can be sorted into four relational models:

- In a communal sharing transaction, such as a family dinner, every member in the relationship is entitled to share in what is available.
- In an authority ranking transaction, such as a decision made in a traditional military unit or a corporation, there is a clear hierarchy, with people lower in the hierarchy deferring to those who are higher up.
- In an equality matching transaction, such as taking turns going through a four-way stop, people operate according to an intuitive sense of balance and fairness.
- In a market pricing transaction, such as buying a used car, people make decisions on the basis of their calculations of the costs and benefits.

The cognitive psychologist Steven Pinker, author of *The Blank Slate* (2002), argues that among these four modes of transactions market pricing is a relatively new phenomenon in the development of the human species:

> Market Pricing is absent in hunter-gatherer societies, and we know it played no role in our evolutionary history because it relies on technologies like writing, money, and formal mathematics, which appeared only recently (Pinker 2002, p. 234).

An important aspect of hunter-gatherer societies is that people belonged to tribes or bands of fewer than 150 people. Everyone knew everyone else, and people expected to interact with one another repeatedly. Small groups with repeated interactions are conducive to establishing trust and confidence in reciprocity, which are requirements for communal sharing and equality matching. When societies become larger and people must interact with strangers, something must replace trust and confidence. Only authority ranking or market pricing can "scale up" to large groups.

Economic historians see the modern market system as having arisen only within the last 300 years. Two features of the modern market system were largely absent until that time. One was flexibility of prices in response to supply and demand. In contrast, ancient and feudal trade took place at prices fixed by custom, authority, and tradition. A second feature of modern markets is that they enable people to work for money and trade for food. Before modern times markets did not have sufficient depth and breadth to allow for specialization and cash crops.

Before 1500 almost all people existed at a subsistence level, living on what they could cultivate. Feudal lords took any excess production and in return provided some public goods, notably protection. As late as 1700 the practice of raising a crop for cash and buying goods and services for money was relatively unknown. Even under late feudalism trade was relatively unimportant, and the terms of exchange were fixed by tradition rather than adjusting to supply and demand. The feedback loop between prices and production did not operate.

Between 1700 and 1850 the market system arose in Western Europe and North America. Better farming techniques allowed people to produce surplus food, giving them something to trade and releasing labor to work in manufacturing. Improvements in transportation, particularly railroads, facilitated specialization and trade. Increasingly, people moved from subsistence farming to a money economy in which they obtained cash for either a crop or physical labor. They then exchanged money for goods and services. Land, labor, and capital became responsive to market conditions.

Adam Smith was the first philosopher to articulate the virtues of the market system fully. In *The Wealth of Nations* (1776) Smith argued that trade was more efficient than self-sufficiency. With trade people can enjoy a wide variety of goods and services while specializing in their labor. In addition, Smith pointed out that the self-interest of producers worked to the benefit of consumers. When consumer demand increases for a good, the price goes up, attracting more producers.

The fact that higher prices induce more production is known as the law of supply. Similarly, a higher price for one good induces consumers to buy less of that good. This is known as the law of demand. Together, the laws of supply and demand determine an equilibrium price and level of output for each good. This impersonal, self-adjusting process is what distinguishes a market economy. In contrast, in a planned economy a bureaucrat determines prices and output levels. In a feudal economy prices are set by custom.

The concept of a market remains counterintuitive in the early twenty-first century. This can be seen in discussions of energy policy, in which it is suggested that the United States could become independent of foreign oil by reducing its domestic consumption and increasing the production of alternative energy. In fact, the world energy market is highly integrated. If the United States reduced its demand for oil, the world oil price would be reduced. However, Americans still would be affected by a disruption in the world supply of oil because such a disruption still would cause the price to rise.

The Ethics of the Market

The market system has ethical virtues in the view of libertarians and utilitarians. The libertarian view is that voluntary exchange among consenting adults is preferable to coercive allocation of resources by government. The utilitarian case for markets, which goes back to Smith, is that market exchanges make people better off.

Markets improve living standards in two ways. First, for any state of knowledge and technology markets achieve an efficient allocation of resources. Flexible prices and competition send signals that accomplish this. Consumers choose the goods and services that satisfy their wants most effectively. Firms choose the inputs and outputs that maximize the value of what is produced. Workers choose the occupations that best apply their talents and interests to social needs.

The second way in which markets improve living standards is through a Darwinian selection of innovative products and processes. Entrepreneurs attempt new techniques, with successful methods surviving and achieving widespread adoption. As unprofitable firms go out of business, failed innovations and obsolete methods fall by the wayside.

The support that markets give to innovation accounts for the high standard of living in the contemporary developed world relative to the past or to the underdeveloped world. The difference is large. Whereas the poorest people in the early 2000s and people who lived 500 ago lived on the equivalent of less than a dollar per day, the average American consumes more than $30,000 in goods and services each year. Market-driven South Korea has a standard of living more than ten times that of communist North Korea.

Feedback between Technological Innovation and Markets

Technological innovation and markets reinforce each other. Markets promote innovation by rewarding success and punishing failure. Technological change broadens markets and makes them more efficient.

Every innovation faces resistance. Scientists may doubt the validity of the theory behind an innovation. Firms are reluctant to discard tried-and-true production methods. Workers in existing industries find their livelihoods threatened by new competition. Consumers may be afraid of new products.

Interest groups that are threatened by new technology attempt to mobilize social institutions to retard innovation. Governments are asked to intervene. For example, some countries in Europe have banned genetically modified food. In the United States opposition to Wal-Mart stores often is driven by store owners and labor unions seeking to stifle competition.

Markets overcome resistance to innovation. The impersonal price system gives its approval to innovations that increase productivity and consumer well-being as firms that adopt the innovations earn profits. Simultaneously, the demise of unprofitable businesses frees resources to be used in more productive ways.

In addition to the ability of markets to foster innovation there is positive feedback from technological innovation to markets. Each improvement in transportation, communication, and trading technology serves to strengthen the market system, increasing the scope of transactions occurring in markets.

The revolution in oceangoing shipping that took place in the fifteenth century helped spur trade, which in turn fostered the transition from feudalism to a market economy. The invention of the steam engine and the railroad lowered shipping costs, enabling cash crops to replace subsistence farming. The internal combustion engine increased the mobility of labor and goods, leading to an increased share of economic activity taking place in the market. Electric motors and labor-saving devices helped release women from household labor and move into market-paid work. In modern times the Internet has increased the breadth of markets, including new possibilities for international trade in white-collar services.

Ethical Concerns with the Market System

There is a long-standing set of ethical concerns with markets. Major problems include inequality, failure to provide public goods, and erosion of cultural traditions.

Markets provide different rewards to different individuals. Those with talent, capital, entrepreneurial instincts, and luck do well. Those who lack valuable talents and/or encounter bad luck do poorly.

Critics of the market system believe that goods and services should be distributed more equally. The socialist thinker Karl Marx (1818–1883) described capitalism not as a neutral system of market pricing but a hierarchical system, with the ruthless capital-owning class exploiting the helpless working class. "From each according to his abilities, to each according to his needs" was Marx's slogan, promising the alternative of communal sharing. However, as anti-Marxists such as Max Weber (1864–1920) and Friedrich Hayek (1899–1992) predicted, large economies could not be made to operate efficiently without markets. Hayek in particular emphasized that the information developed by the price system and individual incentives is much more effective than is central planning.

Critics of inequality tend to view the economy as a zero-sum game, with the success of some individuals necessarily coming at the expense of others. Supporters of the market system view it as a positive-sum game, making it possible for nearly all people to raise their standard of living.

Another area where critics see a zero-sum game is in terms of resource constraints. The argument is that the earth's resources are finite and will be "used up." Economists counter by pointing out that human ingenuity seems boundless. As a result, Jerry Muller comments, "the history of capitalism, as Schumpeter observed, is of finding new ways to make use of formerly insignificant resources. Coal . . . petroleum . . . uranium . . . sand for silicon chips. We may well be at the beginning of the fourth wave of capitalist industrial innovation, the biotechnology revolution" (Muller 2002, p. 391).

Federal Reserve Chairman Alan Greenspan is fond of pointing out that the physical weight of the American gross national product (GDP) is declining, an indication of reduced pressure from economic growth on physical resources. This trend may continue as nanotechnology allows products to be built from raw atoms. Rodney Brooks of the Massachusetts Institute of Technology talks about the possibility of not having to cut down trees and carve wood to make a table but instead simply growing a table with genetic engineering. The technology futurist Ray Kurzweil has suggested in *The Age of Spiritual Machines* (1999) that the information component of GDP is asymptotically approaching 100 percent, which would imply that physical scarcity will never constrain growth.

Another criticism of markets is that they give choices to individuals at the expense of collective purpose. It is argued that there is no overall direction or goal for a market economy. Those who want society to have a common objective see the market as too anarchic. A related criticism of markets is that they fail to pursue cultural ideals: The market may not reward fine art, classical music, or religion.

One strength of the market is that it promotes innovation. However, the market may fail to preserve cultural values and institutions. Occupations made obsolete by market forces represent ways of life that are no longer sustainable. Unique cultural identity may be replaced by homogeneous, anonymous market forces.

Market Imperfections

Economists have found a number of flaws in the market system. The most important are externalities and imperfect information. An externality is a cost or benefit that is not internalized by the market. Pollution is the classic example. The pollution caused by an automobile does not cost its owner anything but the total pollution caused by all automobiles is costly to society. Even though laissez-faire leads to too much pollution, economists still favor market-oriented approaches, including taxes on pollution and tradable pollution "permits." These solutions preserve the flexibility and efficiency of the market while forcing the market to internalize the cost of pollution. Consumers' lack of information provides a rationale for a number of government interventions in the market. For example, government meat inspection helps ensure the safety of meat and regulation of medicines helps protect consumers from harmful or ineffective drugs.

Modern Challenges for the Market System

The market system faces a number of challenges from modern technology. The increased importance of health care and education, the increased role of research and development, the issue of network externalities, and the increased importance of information goods all raise issues for the market.

As human capital increases in importance relative to material resources, health care and education are accounting for an increasing share of the economy. These sectors traditionally have been ones in which government involvement has been extensive.

Health care expenses can soar for the people least able to afford them. Someone who is sick often cannot work. The elderly, who are most likely to have illnesses, are on fixed incomes. Private health insurance may be prohibitively expensive for those with the highest likelihood of needing costly health care. All these issues provide a rationale for government provision of health-care coverage, at least for some segment of the population.

The question is where to draw the line between the market and government involvement. At one extreme are national health-care systems that attempt to put the entire sector under government control. However, this leads to bureaucratic rationing of care and, as is the case any time market forces are suppressed, to slow adoption of new technology and lack of innovation. The United States, which has the most market-oriented health-care system in the industrialized world, also does the most to advance the state of the art through pharmaceutical development, diagnostic equipment, and innovative medical procedures.

Education is another area where the individuals with the greatest needs may be least able to afford the best service. As with health care there is a long tradition of government involvement. Critics argue that this has meant slow innovation and the persistence of ineffective schools. Some economists believe that a more market-oriented approach of giving parents vouchers and letting entrepreneurs supply schooling would be more effective.

The inequality that characterizes market outcomes may be a more significant issue as education and health care increase in importance. One may be able to shrug at the differences between what the rich and the poor can afford in terms of cars or wine, but it is more difficult to feel comfortable when the rich are able to obtain better medical care and education.

Economic growth depends on research and development. In the future the fields of computer science, biotechnology, and nanotechnology will be particularly important to the economy. As a theoretical matter, "basic research," which is generally applicable but yields no immediate profits, will be undersupplied by markets and will have to be supported by the government. By the same token "applied research," which is specific and provides immediate rewards, is best done by private firms so that unprofitable ideas are discarded quickly.

In practice the distinction between basic research and applied research is not as easy to draw. In any event the questions of how much the government should invest in research and where it should invest are very important. People's future standard of living will depend to a large extent on how well those decisions are made.

Modern technology gives rise to networks, in which the size of the network is a source of value. For example, the value of a fax machine is low if no one else has one. When everyone else has a fax machine, the value is much higher. The same is true for e-mail accounts, instant messaging services, CD burners, and popular word-processing file formats.

People may choose a word-processing program for compatibility with their colleagues even though they would prefer the features in a different program. In theory everybody could choose to use an inferior program because it is the program others are using. In that way the market gravitates toward an inferior standard. This possibility is called a network externality.

Another aspect of the economy that has changed in recent years is the increased importance of information goods relative to physical goods. Information goods pose a challenge to the market system.

With physical goods the price system is effective at allocating resources. The price of a bicycle or an apple reflects the marginal cost of producing and distributing those goods. Moreover, there is rivalry in consumption: The bicycle that one person rides is one that another person cannot ride; the apple that a person eats is an apple that nobody else can eat.

With information goods the marginal cost of production and distribution approaches zero. Once an essay or a song is stored as information (bits) on a computer, it costs very little to copy those bits or send them to another computer halfway around the world. Furthermore, an author's ability to read an essay on his or her computer does not interfere with another person's ability to read that essay.

The dilemma caused by information goods is that the marginal cost of production and distribution is zero but the up-front development costs may be substantial. For example, consider the case of a new pharmaceutical to treat diabetes or AIDS. That drug may cost hundreds of millions of dollars to develop. However, the pills can be manufactured for pennies apiece. What should be the price? On the one hand, the price should be low enough not to discourage use, which at the margin costs very little. On the other hand, the price should be high so that companies recover their up-front costs and have an incentive to continue to innovate.

There are a variety of possible pricing mechanisms for information goods, none of which is perfect. In the case of pharmaceuticals the government grants a temporary monopoly in the form of a patent. This allows drug companies to set prices above marginal cost so that they can recover the cost of research. However, at the margin this discourages the use of medications because the price is higher than the marginal cost of production.

The challenge with research-intensive goods is to come up with a way to cover fixed costs while leaving the marginal price as low as possible to encourage broad use. Price discrimination—charging higher prices to the consumers most willing to pay—can be not only profitable but also socially optimal. Alternatively, it may be desirable for many consumers to combine to cover up-front costs through a subscription model or a membership model. It may be desirable for taxpayers to cover some up-front costs through a subsidy or prize offered by the government.

Doomsday Scenarios

There is a long-standing tension between economic growth and cultural stability. Markets, which facilitate the former, undermine the latter. Many futurists project an acceleration of technological change in the twenty-first century. This has the potential to raise the standard of living dramatically, but it also has the potential to cause great culture discontinuity. There are many examples:

- In computer science, Kurzweil (1999) argues that Moore's law, which roughly states that the power of computers doubles about every eighteen months, implies that there will be a computer with the intelligence of a human brain by about 2030. Moreover, once computers catch up with humans, they will surpass humans rapidly. Thus, the long-term future is one in which humans and machines will be integrated and coevolve, with the human species becoming inferior or extinct.
- In nanotechnology Eric Drexler (1986) and Bill Joy (2000) warn of the possibility of chemical production processes expanding uncontrollably. In the worst case, dubbed the "gray goo scenario," a substance could reproduce indefinitely until it swallowed the planet.
- In biotechnology the President's Commission on Bioethics (2003) emphasized a number of possible dystopian scenarios, including one in which human beings are designed and created to serve the purposes of their masters. The commission also pointed to issues raised by medicines that enhance performance or might prolong life indefinitely.

If these doomsday scenarios are possible technologically, markets are unlikely to prevent them. Accordingly, fear of doomsday scenarios could lead people to favor strong, worldwide government action to intervene in markets. Opposition in Europe to genetically modified food and opposition in the United States to embryonic stem-cell research could be symptoms of antimarket regulation to come.

The Future

Markets are conducive to technological innovation, and vice versa. People who place a high value on the benefits of technological innovation tend to want to expand the scope of the market. People who are more concerned with the risks of technological innovation are more inclined to favor government intervention.

The chief benefit of technological innovation is that it raises people's standard of living. People's labor, capital, and natural resources become more productive as they use science and engineering to develop more efficient techniques for satisfying human wants.

The combination of markets and technological innovation creates economic inequality. Successful entrepreneurs, business leaders, and others earn outstanding rewards. Unskilled workers have a higher standard of living than was the case a century ago, but they are significantly less wealthy than those at the top of the income distribution.

Markets and innovation also cause cultural dislocation. Old ways of life disappear, and people must adapt to new circumstances. The possibility appears to exist for dramatic, discontinuous change.

People are close to having capabilities that may undermine their identity as human beings. Will people merge with machines? Will pharmacology or genetic engineering give people control over their emotions, memories, aging process, and physical and cognitive skills? Will scientific discoveries serve primarily to enhance the lives of the rich, or will they also give new opportunities to the poor?

The market offers only one way to answer these types of questions: with trial and error. Individual responses to opportunities and incentives will cumulate to an overall social result. Those who want the outcome to be arrived at by a different process, such as the deliberations of moral philosophers and experts, will seek to find a way to disrupt the decentralized, experimental market mechanism and replace it with something more planned and controlled.

ARNOLD KLING

SEE ALSO *Capitalism; Environmental Economics; Libertarianism; Smith, Adam.*

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MARX, KARL

Karl Marx (1818–1883) was born in Trier, Prussia on May 5 and died in London on March 14. He was educated in Trier and at the universities of Bonn and Berlin, thus coming under the influence of Georg Wilhelm Friedrich Hegel (who he later radically criticized) before receiving his doctorate in philosophy from the University of Jena in 1841. Throughout most of his adult life, he was assisted both financially and intellectually by Friedrich Engels (1820–1895), with whom he coauthored such works as *The German Ideology* (1845–1846) and "The Communist Manifesto" (1848).

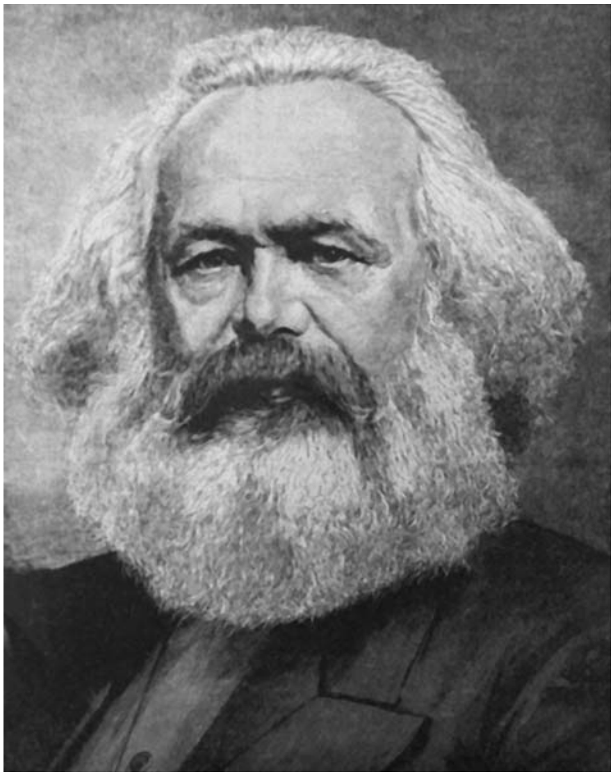
Marx wrote mainly on capitalism as an economic system, and is most closely identified with the multivolume *Capital* (Vol 1 [1867]; Vol. 2 [1885]; Vol.3 [1894], Vols. 2 and 3 published by Engels after Marx's death). This massive 2,500 page work explores the capitalist system in terms of the logic of its functioning, its historical progression, and its fate. Marx's writings on science are scattered and fragmentary, and his discussions of technology, though more detailed, are largely unsystematic. Therefore this entry will concentrate more on his views on ethics and morality, the implications of which are enormous.

Technology and Science

Technology and science played an important role in Marx's thought. His general theory of human history, *historical materialism*, gave technology a major role in forming the foundation of society and in the process of historical change. Every society rests on an economic base or mode of production, which includes both forces and relations of production. The forces of production consist mainly of the level of technological development a society has achieved and of the features of the natural environment in which it is located. Relations of production are the social and economic relations people enter in the process of production and involve the ownership of the productive forces. The productive forces might be owned and controlled by the entire society, or, more commonly, by a relatively small segment of society. Those who own the productive forces dictate their operation and often subject the mass of the population to conditions of severe exploitation and oppression. The other major part of every society is the superstructure, which consists of politics, law, family life, religion, and the mode of consciousness, or collective forms of thought and feeling. The superstructure rests on the economic base and is largely determined by it.

Marx regarded the earliest societies as constituting forms of primitive communism. Here people lived by using simple technologies of hunting, fishing, agriculture, and animal husbandry. Because of the communal nature of such societies and the absence of class divisions and exploitation, they would have been idyllic except for their low level of technological development, which prevented people from adequately satisfying basic needs. Gradually, however, progress in technology enhanced human power to manipulate the environment, but in ways that led to the formation of private property and class divisions. European society passed through a slave mode of production in ancient times and then a feudal stage. Capitalism succeeded feudalism.

Despite his savage criticisms, Marx appreciated the great achievements of capitalism, the foremost being its enormous capacity for the development of technology in the form of modern industry. In his general theory of history, Marx saw capitalism as a prerequisite for the development of socialism because the latter, in order to meet basic human needs and allow for everyone's self-realization and self-fulfillment, requires material abundance. Capitalism developed technology to a level sufficient for the creation of this abundance. But socialism would develop technology even further, thus allowing for the elimination, or at least the reduction, of the most unpleasant and burdensome forms of work.



Karl Marx, 1818–1883. This German philosopher, radical economist, and revolutionary leader founded modern "scientific" socialism. His basic ideas—known as Marxism—form the foundation of socialist and communist movements throughout the world. *(The Library of Congress.)*

Marx had much less to say about science than he did about technology, but he was a major proponent of science, both because of its ability to produce intellectual knowledge and its capacity for the development of industry. In the section of the "Economic and Philosophical Manuscripts" (1844) devoted to private property and capitalism, Marx writes that "natural science has invaded and transformed human life all the more *practically* through the medium of industry; and has prepared human emancipation" (Marx 1978b, p. 90). Also "Natural science will in time subsume under itself the science of man, just as the science of man will subsume under itself natural science: there will be *one* science" (Marx 1978b, p. 91).

Indeed Marx regarded historical materialism as a scientific theory that could be empirically verified (Husami 1980). He was also a great admirer of Charles Darwin and highly commended *Origin of Species* (1859) to Engels, saying that it served as a basis in nature for their theory of history. Later, in his speech at Marx's grave, Engels was to say, "Just as Darwin discovered the law of development of organic nature, Marx discovered the law of development of human history" (Engels 1978, p. 681).

Ethical Perspective

Marx did not have an ethical theory, or a theory of justice, in the sense of such great moral philosophers as Immanuel Kant or John Rawls. In fact Marx explicitly disavowed all talk of justice and rights, in part because they belong to the juridical superstructure rather than the technoeconomic base. In capitalist society, juridical notions are part of the way in which the capitalist mode of production and its ruling class are maintained. In "Critique of the Gotha Programme" (1875) he argues that, in discussions of socialism, notions of justice and rights are *obsolete verbal rubbish* and *ideological nonsense*. Under socialism there will be no need for rights and liberties, their *raison d'etre* having disappeared. The rights and liberties found in capitalist society only exist because capitalism is a highly inadequate mode of production from a human point of view (Buchanan 1982).

In his famous essay "On the Jewish Question" (1843), Marx drew an important distinction between political freedom and human freedom. Political freedom consists of the constitutional liberties that people have in capitalist society: the right to property, speech, and assembly, equal treatment before the law, and so on. Political rights are a cover for an absence of human rights. Human freedom involves the opportunity of all individuals not only to have the full satisfaction of their basic needs, but also the opportunity to realize their essential nature as human beings through creative and self-fulfilling work. In capitalist society, everyone has political freedom but only a few can achieve true human freedom. Only in socialist society can human freedom become commonly achieved. This vision of freedom is intimately tied to Marx's views on technology, because true human freedom requires a very advanced level of technology, which a fully realized socialist society will have.

Nevertheless although Marx did not develop an ethical theory and rejected its need or desirability, he did have moral or evaluative notions that guided his critique of capitalism and his advocacy of socialism. Marx was a moralist who had no moral theory, that is, he "advocates principles that are supposed to guide present-day social and political choice in the same way as a political morality" (Miller 1984, p. 51). In various writings, Marx refers to the misery and sufferings of the working class under capitalism, of the deadening and degrading nature of work created by the capitalist division of labor (and thus of the alienation and dehumanization of the worker), and of how capitalism "enforces on the laborer abstinence from all life's enjoyments" (Husami 1980, p. 43). The capitalist class receives all the material and intellectual benefits of society while the proletariat assumes all its burdens. Capitalism exploits the worker, and exploitation is variously described as robbery, embezzlement, plunder, and theft. Husami argues that these evaluative notions are tantamount to a conception of justice despite the fact that Marx formally rejected all talk of justice.

Marx also seemed to have a theory of distributive justice (Husami 1980). As set forth in *Critique of the Gotha Programme* (1875), the first phase of the new socialist society will be guided by the principle *to each according to his abilities*. Workers receive from society payment in accordance with the labor contribution they make. Individuals differ in their mental and physical endowments and some contribute more labor than others; those who contribute more receive more in return. But inequalities never become significant because society provides for every person's social needs (healthcare, education, and so on). Whatever inequalities do exist are not the result of power and class differences because private ownership of the means of production has been abolished.

But this first phase of socialist society, having just emerged from capitalist society, is still stamped with defects. There will emerge a higher phase of socialist or communist society, and "only then can the narrow horizon of bourgeois right be crossed in its entirety and society inscribe on its banner: From each according to his ability, to each according to his needs" (Marx 1978b, p. 531). In this phase, society takes into consideration the fact that individuals differ not only in their talents and abilities, but also in their needs. Because some individuals have greater needs than others, they should be rewarded accordingly. This highest form of socialist society is guided by the principle of full individual self-development, and as such must provide each person with the resources necessary for that development. Inequalities therefore remain. Again, however, these inequalities do not arise from class position (because there are no classes) and do not involve any exploitation. Moreover the inequalities are not great and do not affect the satisfaction of basic needs related to physical well-being and education, because these are automatically provided to everyone. (See Wood [1980] for a very different interpretation of Marx on justice. For an interpretation partway between Husami's and Wood's, see Brenkert [1980].)

Historical Failures and Legacy

The implications of Marx's thinking on science and technology are relatively minor, but his thought has enormous implications for an ethical assessment of society. Marx's predictions concerning future socialist revolutions and the content and nature of socialist society have been overwhelmingly repudiated by the past 100 years of history. Socialist revolutions occurred where Marx did not expect them, and utterly failed to occur in those places where he thought they would. And the so-called socialist societies that did develop were for the most part a grotesque deformation of what he expected. These failures lie both in a flawed theory of history—Marx badly misunderstood the historical trajectory of capitalism—and in a failure to appreciate the importance of a theory of justice and morality. Marx's view that political rights and liberties are merely expressions of a defective bourgeois mode of production, and as such will be irrelevant and unnecessary in a socialist mode of production, opened the way for, and gave license to, some of the most brutal dictatorial regimes in human history. Marx did not foresee this outcome, and certainly would have vehemently rejected it. The ideals may have been noble, but their actual implementation proved to be an entirely different matter.

Many different kinds of Marxism have developed since Marx's time, including the critical theory of the Frankfurt School (Adorno, Horkheimer, Marcuse, Habermas), the Italian Marxism of Antonio Gramsci, French existentialist Marxism (Sartre), Wallerstein's world-system theory, and anticolonialist theory. Some of these are as different from one another, and from classical Marxism, as they are similar. Critical theory, for example, is highly critical of modern science and technology in a way that would have been inconceivable to Marx. In terms of ethics, a wide range of complex positions can be found.

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SEE ALSO *Alienation; Capitalism; Communism; Critical Social Theory; Freedom; Hegel, Georg Wilhelm Friedrich; Marxism; Political Economy; Socialism; Sociological Ethics; Work.*

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MARXISM

An intellectual tradition and political movement initiated by Karl Marx (1818–1883) and Friedrich Engels (1820–1895), Marxism has devoted much attention and debate on matters of science, technology, and ethics. Marx and Engels themselves were particularly influenced by Darwinism and saw themselves as extending an understanding of organic evolution into human history. They believed that developments in the natural sciences of their times required elaboration of the philosophical and sociological consequences in the direction of a dialectical and historicist form of materialism. But they were critical of existing materialist currents as undialectical and existing dialectical positions as idealist. In the intellectual division of labor between Marx and Engels, Marx devoted his efforts to economics, while Engels wrote on philosophy, science, culture, morality, and gender, and entered into polemics with critics. His *Dialectics of Nature,* published posthumously in 1927, explores the philosophical implications of the natural sciences.

Marxism held that capitalism has played a crucial part in developing science and technology, but that only socialism could fulfill their potential and organize an equitable distribution of their benefits. For Marxism, capitalism was an inherently contradictory mode of production. It was a system based on the primacy of market forces and private ownership of the means of social production, generating a basic class division between those who own the means of production and those who own only their labor power. Although capitalism led to an unprecedented development of productive forces, rising standards of living, and advances in science and technology, it also created massive inequality, parasitism, and alienation. Capitalism was a historically necessary stage in human development, but socialism was a necessary next step. A socialist system based on the social ownership of the means of social production would create a social order based on the principle "from each according to his or her abilities, to each according to his or her needs."

Marxism pioneered the field of sociology of knowledge, including the sociology of science and technology. It has insisted that science and technology are not isolated, self-contained activities, but develop in complex interaction with a whole range of other processes: philosophical, cultural, political, and economic forces. Within this interaction, the mode of production is decisive. All existing scientific theories, technological developments, economic structures, political institutions, philosophical positions, legal codes, moral norms, sexual roles, cultural trends, aesthetic tastes, and even common sense are inextricably interrelated and determinately shaped by the dominant mode of production. Marxism thus made extraordinarily strong claims regarding the philosophical assumptions and sociohistorical basis of scientific knowledge. At the same time it put considerable emphasis on ideology, arguing against the view that science itself is neutral and that only the use or abuse of science is ideological. Yet Marxism perceived recognition of these aspects as enhancing science and not being in conflict with the rationality and credibility of science.

Developments in the USSR

There have been many twists and turns in the history of Marxism due to the impact of new scientific discoveries, technological developments, philosophical trends, and political formations. Marxists of subsequent generations got caught up in many controversies. Along with political conflicts over evolutionary versus revolutionary paths to socialism, those of the second generation took various positions on the epistemological implications of the natural sciences. Vladimir Ilyich Lenin's (1870–1924) *Materialism and Empirio-Criticism* (1909) is a product of the philosophical debates of that period.

After the October revolution of 1917 that gave rise to the Union of the Soviet Socialist Republics (USSR), Marxism came to power as the official ideology of the new Soviet state, meaning that its visionary ideas could be tested in social practice. There were fiery debates about how to do so in virtually every sphere: from strategies for industrialization and agriculture to nationalities policy about the fate of different nationalities/national cultures within the USSR, socialist morality, science policy, free love, and the future of the family.

In the early years of the revolution, the movement for proletarian culture, *proletkult*, led by Alexander Alexandrovich Bogdanov (1873–1928), a doctor who advocated a collectivist subjectivism in the philosophy of science, argued that the culture of the bourgeoisie—from art and literature and morality to science and technology—was saturated with class ideology and could not serve the needs of the proletariat. *Proletkult* required a specifically proletarian culture, including proletarian science, because science had been shaped by the capitalist mode of production and needed to be collectivized and revolutionalized, putting an end to the fragmentation of scientific knowledge and the competitive drive of capitalist production. For *Proletkult* socialism was impossible without science, but it was also impossible with bourgeois science. Lenin and others took issue with this argument, contending that it was premature and sectarian to sweep aside the existing intelligentsia and existing knowledge. Lenin insisted that it was necessary to embrace bourgeois science and knowledge while critically reconstructing it. Bogdanov's movement dissipated within a few years, especially after he, as director of the Institute for Research in Blood Transfusion, died in an experiment on himself.

Nevertheless the USSR put much emphasis on working out a distinctive approach to science and technology under the banner of Marxism. Many political and philosophical debates flourished through the 1920s. The relationship of philosophy to the empirical sciences was very much in play through the prolonged debate between those who were grounded in the empirical sciences and emphasized the materialist aspect of dialectical materialism and those who were more grounded in the history of philosophy, particularly Hegel, and emphasized the dialectical dimension of dialectical materialism. It has been an ongoing tension in the history of Marxism, playing itself out in the intellectual ferment and institutional transformation of a socialist revolution. Philosophy was considered to be integral to the social order. Political leaders, particularly Lenin and Nikolai Ivanovich Bukharin (1888–1938), participated in philosophical debates as if these issues were matters of life and death, of light and darkness. Even while preoccupied with urgent affairs of state, they polemicized passionately on questions of epistemology, ontology, ethics, and aesthetics.

Bukharin was an advocate of the new economic policy aimed at achieving agricultural productivity and steady industrialization, but was outmaneuvered and defeated by Joseph Vissarionovich Stalin (1879–1953). Although he had fallen from the heights of political power, he continued to work as constructively as possible and devoted himself particularly to the application of science to economic planning during the first five-year plan. Bukharin believed that Marxists should study the most advanced work in the natural and social sciences and cleanse their thinking of the lingering idealism inherent in quasimystical Hegelian formulations. In *Historical Materialism* (1921), used as a basic text in educational institutions, he interpreted dialectics in terms of conflict and equilibrium. Other Marxists, such as the Italian Antonio Gramsci (1891–1937) and the Hungarian Georg Lukacs (1885–1971), saw Bukharin as the personification of a positivist tendency in Marxism. Lukacs's book *History and Class Consciousness*, rejecting Engels's concept of the dialectics of nature, drew a storm of controversy.

In 1931 Bukharin led a Soviet delegation to the Second International Congress of History of Science in London, projecting enormous enthusiasm for the role of science in a socialist society. Boris Mikhailovich Hessen (1883–c. 1937) delivered one of the most influential papers ever in the historiography of science, giving an ideological analysis of Newton's *Principia*, setting it firmly within the social, political, and economic struggles of the seventeenth century.

Both Hessen and Bukharin perished in the purges. Bukharin was the most prominent defendant in the spectacular Moscow trials and was executed. Even during his imprisonment he continued to write of how Marxism forged the most progressive path for science and technology, as affirmed in his posthumous work *Philosophical Arabesques* (2005), which was discovered decades after his death.

Another Marxist intellectual who espoused ideas relevant to science and technology was Leon Trotsky (1879–1940). He was inclined to the mechanist position in the debates of the 1920s and saw the role of philosophy as systematizing the conclusions of all the positive sciences. After Lenin's death in 1924 Stalin also outmaneuvered Trotsky, rejecting his pursuit of a worldwide socialist revolution in favor of developing socialism in the Soviet Union. Dismissing him from the government and expelling him from the party, in 1929 Stalin forced Trotsky into exile where he was assassinated.

Beyond and Within the USSR

The intellectual energy and social purpose of the Soviet philosophers and scientists had great impact on their international audience, especially in Britain, where influential scientists, such as J. D. Bernal (1901–1971), J. B. S. Haldane (1892–1964), and Joseph Needham (1900–1995) took up the challenge of a sociohistorical analysis of science and put their energies into a movement for social responsibility in science.

Marxism captured the imagination of many intellectuals in the west in the 1930s. Some of the most brilliant, such as David Guest (1911–1938) and Christopher Caudwell (1907–1937), died in the Spanish Civil War. In *The Crisis in Physics* (1939), Caudwell extended his ideological analysis of all spheres of thought into physics, seemingly the area most remote from ideological involvement. Caudwell saw a causal connection between the crisis in physics and those in biology, psychology, economics, morality, politics, art, and, indeed, life as a whole. The cause of the crisis in physics was not only the discrepancy between macroscopic or relativity physics and quantum or subatomic physics, but the deeper problem was the metaphysics of physics. What it came down to was the lack of an integrated worldview that could encompass all the sciences with their dramatically expanding experimental results. Science was decomposing into a chaos of highly specialized, mutually repellent sciences, whose growing separation increasingly impoverished each of them and contributed to the overall fragmentation of human thought. Ironically the very development of each of the sciences in this situation accentuated the general disorientation and resulted in scientists falling back on eclecticism, reductionism, positivism, and even mysticism.

Back in the USSR, a number of those who were fervent advocates of the new social order being created there were accused of undermining it and perished. All the debates of the 1920s took a sharp turn from 1929 on with the frenzy of the first five-year plan and the intensified pressure to bolshevize every institution and discipline. The intelligentsia was told that the time for ideological neutrality was over. They had to declare themselves for Marxism and for the dialectical materialist reconstruction of their disciplines or evacuate the territory. All controversies, whether between Marxism and other intellectual trends or between different trends within Marxism, were sharply closed down through the 1930s. There was to be one correct line on every question. Any deviation was considered to be not only mistaken but treacherous.

There was resistance in many areas. Geneticists fought back against attempts by brash bolshevizers to override the process of scientific discovery. The protracted struggle over the theories of Trofim Denisovich Lysenko (1898–1976) took the debate over proletarian science into difficult and dangerous territory, making legitimate issues such as hereditarianism versus environmentalism into a struggle for power where all intellectual and ethical criteria were at times abandoned. Nikolai Ivanovich Vavilov (1887–1943), an internationally prominent geneticist and ardent advocate of the unity of science and socialism, defended genetics and resisted the onslaught of Lysenkoism. He was accused of sabotage of agriculture and died in a prison camp.

These developments in Soviet intellectual life were inextricably tied to the rhythms of Soviet political and economic life. The way forward with the first five-year plan was far from smooth and uncomplicated. There was violent resistance to the collectivization of agriculture and peasants were burning crops and slaughtering livestock rather than surrender. There was one disaster after another in the push to industrialization. There was a fundamental contradiction between the advanced goals that were to be achieved and the level of expertise in science, engineering, agronomy, and economics, indeed a general cultural level, needed to achieve them. There was panic and confusion and desperation. There was reckless scapegoating. Breakdowns, fires, famine, and unfulfilled targets were attributed to sabotage and espionage. There was a blurring of the lines between bungling and wrecking, between association with defeated positions and treason, between contact with foreign colleagues and conspiracy with foreign powers.

After the death of Stalin, subsequent Soviet leaders, particularly Nikita Sergeyevich Khrushchev (1894–1971), in the critique of Stalinism after the Twentieth Party Congress (1956), and Mikhail Sergeyevich Gorbachev (b. 1931), in the period of glasnost and perestroika (1985–1991), attempted to put Soviet life, including its science, on a new basis, but, some contend, the traumas of the period prevented such changes.

Outside the USSR: New Left Marxism

From the 1940s on, Marxism came into the ascendancy in the academies of much of Eastern Europe and parts of Asia, Africa, and Latin America following the succession of communist or socialist parties to power in such countries as Czechoslovakia, Yugoslavia, China, Mozambique, and Cuba. The academicians of the German Democratic Republic were particularly devoted to developing a philosophy of science in the sense of elucidating the philosophical implications of the natural sciences.

Marxism also played a special role in French intellectual life. Some Marxist scientists, such as the physicist Paul Langevin (1872–1946) and biologist Marcel Prenant (1893–1983) saw dialectical materialism as illuminating their sciences and looked to the Soviet Union as developing science in a way that would liberate human society. Georges Freidmann (1902–1977), however, who made original contributions to industrial sociology, came to think that Soviet science was drowning in facile formulas and sterile polemics. Later many French Marxists, such as Jean Paul Sartre (1905–1980) and Maurice Merleau-Ponty (1908–1961) adapted their Marxism to existentialism or phenomenology. Others such as Louis Althusser (1918–1990) took Marxism in the direction of structuralism. It emphasized scientificity, but did not engage meaningfully with actual science.

In the 1960s and 1970s the influence of Marxism again became a formidable force, not only in countries defining themselves as socialist, but in the most prototypically capitalist ones as well. Although it never took state power in these milieus, Marxism did seize the intellectual and moral initiative for a time.

During this period a new left arose, posing new questions to the old left, as well as to the old right and the ever shifting center. Eurocommunism represented a merging of old and new left currents, which promised much at the time. The most vibrant debates of the day were conducted within the arena of Marxism. There were many journals such as *Science and Society* (1936–), *Marxism Today* (1953–1991), Socialist Register (1964–), and *New Left Review* (1960–) in which the discussion flourished.

On all matters touching on science, technology, and ethics, there was a new left challenge. The new left view of science represented a sharp break from the old left, for example the older radical science movement in Britain, exemplified by such figures as Bernal and Haldane. Science, as the older left saw it, was a progressive force. It was essential to socialism and socialism was essential to science. The *Radical Science Journal* (1974–1983) took the Marxist emphasis on the ideological nature of science in the direction of a radical social constructivism that sometimes tended to reject the cognitive and liberating potential of science. A long-standing leftist position, characterized by a blending of neo-Kantian, neo-Hegelian, and, more recently, postmodernist ideas with Marxist ideas, is represented by the Frankfurt School's (1923–) critical social theory, which identifies science with bourgeois ideology, counterposes scientific with humanistic values, and tends to hostility toward the whole sphere of the natural sciences. The divisions of the left on the question of science flared up in the science wars of the 1990s and were dramatized by the controversy that arose between the journal *Social Text* and Alan Sokal in 1996.

From the mid-nineteenth century and continuing into the early twenty-first century, Marxism made major contributions to intellectual history. It may at times seem to be a discarded theory, but one would be mistaken in believing that Marxism might not surge again.

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SEE ALSO *Class; Communism; Conservatism; Critical Social Theory; Marx, Karl; Socialism; Weil, Simone.*

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MATERIAL CULTURE

Material culture may be defined as the human significance of the totality of tangible artifacts that humans have produced. These artifacts range from the mundane and perishable to the monumental and enduring, and have been linked together in distinctive ways across place and time. Scholarly attention to material culture beyond technical analyses is divided among mainstream disciplines such as history and anthropology and specializations such as art history, archaeology, history of technology, cultural geography, and philosophy of technology. In all instances, questions of the ethical implications of material culture call for reflective consideration.

Basic Transformations

Despite the manifold plurality of material cultures across places and times, the Industrial Revolution of late-eighteenth-century England introduced a watershed into human history that began a radical transformation in the general character of material culture across all of its permutations. The steam engine for the first time in human history provided a tireless, ubiquitous, and powerful prime mover. Coal became a seemingly limitless energy source, and iron and steel constituted a material for structures that were both large and finely articulated.

Already in the nineteenth century, this transformation exhibited creative and destructive aspects, both noted by Karl Marx (1818–1883) and Friedrich Engels (1820–1895) in *The Communist Manifesto* (1848). About the creative side they said: "The need of a constantly expanding market chases the bourgeoisie over the whole surface of the globe. It must nestle everywhere, settle everywhere, establish connections everywhere" (Marx and Engels 1955 [1848], p. 13). This creative process has continued over the past century and a half and is much discussed in the early 2000s under the term *globalization*.

The destructive side Marx and Engels described as follows: "All that is solid melts into the air, all that is holy is profaned, and man is at last compelled to face with sober senses his real conditions of life and his relations with his kind" (Marx and Engels 1955 [1848], p. 13). They described the dissolution more specifically in their description of how the labor power of workers was being torn out of its traditional context of personal relations, social bonds, and ownership of stores and tools and converted into a commodity whose price was being more and more depressed. Marx's *Capital* (1867) extended this analysis to all those things that used to be rooted in the production and consumption of the household and were pulled into the market by industry and commerce. This process too is still being discussed vigorously, and Anglo-American scholars have coined the term *commodification* as a covering concept.

Both creation and destruction are pervaded by a third process, a dematerialization and refinement of production and consumption. John Kenneth Galbraith (1967) noted how the basis of economic power had shifted since the eighteenth century from land via capital to expertise. Daniel Bell (1973) described a similar shift from extraction via fabrication to processing. Remarkably, Thomas J. Schlereth (1982) observed a broadly analogous process of sophistication in the scholarly concern with material culture. He distinguished the "The Age of Collecting (1876–1948)" from the "The Age of Description (1948–1965)" and the "The Age of Analysis (1965–)." The current end phase of this development is also much considered and contested in the early twenty-first century under such headings as *the computer era* or *the information age*.

Modern technology began as a widespread activity of inspired tinkering and ingenious inventing in the last third of the eighteenth century. It was well underway before the natural sciences in the nineteenth century caught up with technology and, through the explanation of heat, pressure, electricity, and materials, became an engine of innovation. Technological devices, in turn, began to open up deeper dimensions of familiar phenomena and entirely new areas of investigation. Research and development have to this day been the major sources of productivity growth and thus of an exploding material culture. By now technology and science have so fulsomely embraced one another that it has become fashionable to see them as one creature—technoscience (Ihde and Selinger 2003). It is an undeniable fact, to be sure, that much of science is undertaken for technological gain and that technology has stimulated science and made it more effective; yet technology and science remain distinguishable and, from the moral point of view, need to be distinguished.

Ethical Assessment

When it comes to its ethical examination, Marx may again be considered a founding figure in his ambivalence about the moral quality of the newly emerging material culture. Under the surface, Marx regretted the loss of traditional things and relations. Overtly, however, he considered the world of the past as one of oppression, exploitation, and even idiocy, and he embraced the Industrial Revolution and its fruits. What he emphatically found objectionable and doomed was not the quality of the new material culture, but maldistribution in the power over production and in the blessings of consumption.

Because it does not examine or question the internal moral structure and properties of the artifacts modern technology has produced, Marx's moral judgment of the material culture is an extrinsic one. It has in fact become the received wisdom of social theory that there are no morally significant internal structures or properties and that tangible technology is thus morally neutral. Accordingly, when considering how standard ethical theories and more popular moral positions bear on contemporary material culture, all those bearings turn out to be extrinsic.

This does not mean they are unimportant. Consider the two leading contemporary ethical theories. The first is the ethics of equality and liberty, masterfully represented by John Rawls (1999) and technically known as deontology. It contends that inequalities in power and prosperity are warranted only if everyone has an opportunity to become powerful and prosperous, and if inequalities are to the benefit of the poor and powerless. This implies a significant and well-warranted critique of how prosperity and the material objects of which it consists are distributed nationally and globally. At the same time Rawls makes the debatable claim that prosperity and opportunity in themselves can be defined in a morally thin or neutral sense.

The other leading contemporary moral theory is utilitarianism, which is concerned with maximizing the happiness of a given population (Sidgwick 1981 [1907]). The animating principle of utilitarianism is as intuitively simple and attractive as it is technically difficult and forbidding. Finding a measure for happiness, establishing the maximizing procedure, and defining the relevant population have turned out to be endlessly complicated and controversial problems that at every turn threaten implementation with paralysis. Utilitarianism becomes a feasible program if one substitutes prosperity for happiness and agrees to measure prosperity with money. The resulting moral theory—what may be termed monetary utilitarianism—dominates public policy decision-making in the advanced industrial countries and retains some of the affirmative and forward-looking spirit of the original conception. Maximizing becomes equated with increasing the gross domestic product by all available means, a person's happiness is measured by income and prosperity, and the relevant population is the citizenry of a nation. All this is animated by a spirit of optimism and tolerance. But utilitarianism, monetary or not, remains neutral when it comes to the moral quality of the goods that, along with the services, compose prosperity or lead to happiness. This is how utilitarians understand tolerance.

Environmentalism and Religion

The two more popular moral positions that bear on the material culture are environmentalism and religion. Environmentalists, broadly speaking, regard contemporary material culture as hypertrophic (growing excessively) and ruinous. Hence they counsel a reduction of material possession and consumption. This too is a moral injunction on the material culture—and one that is important and would be beneficial if heeded. But as practiced, environmentalism would not require a deeper understanding and a transformation of the moral quality of material culture. One might continue to enjoy the same tangible and consumable objects, albeit in environmentally sustainable versions—sitting on natural-fiber couches, drinking beer brewed from organically grown barley and hops, eating chips made from genetically unmodified corn, staring at a television set that, at the end of its useful life, the producer has to take back and recycle in its entirety. All of this would make the material culture simpler in quality and reduced in quantity, but not essentially different in character.

The most pointed and the best-known critique of the material culture comes from religious ethics. It condemns materialism—the excessive concern with material goods. Pope John Paul II has been a vocal proponent of this criticism, and his voice may seem a lonely one because, at least in the United States, Christianity and materialism seem to be anything but antagonistic. When questioned, however, Americans profess to be worried about materialism (Wuthnow 1996, Schor 1998). These worries surface in movements that range from Luddism to voluntary simplicity (Elgin 1981).

Materialism is an ill-defined phenomenon. The concern with material objects covers such disparate things—television sets and sport-utility vehicles (SUVs) are material objects, but so are musical instruments and bicycles. Can't one at least say that, no matter the kinds of material objects, there are simply too many? Aren't humans consuming too much and thus running out of raw materials, food, timber, and energy? And in the process, aren't the industrialized countries of the northern hemisphere exploiting those of the globe's southern half? According to Mark Sagoff (1997), however, these apprehensions turn out to rest on misconceptions.

Two conclusions appear to follow. First, the religious objection to materialism stands no matter how materialism is defined. Excessive concern with any kind of material object is a distraction from spiritual matters or the afterlife. Second, secular worries about materialism are unfounded, and a secular outlook on life cannot have objections in principle to the current way of taking up with material culture. Both conclusions leave one uneasy, however. As to the first, excessive concern with tangible stuff is morally objectionable by definition. But what about appreciation and enjoyment of the visible world? Some religious traditions at least think of the tangible world as created by God and therefore as fundamentally good. Secular folks who worry about materialism have something specific in mind, namely, consumerism (Wuthnow 1996, Schor 1998). Materialism in this sense is a preoccupation with a particular kind of material object, consumable objects, presumably. There is a need, then, for an intrinsic analysis of material goods and for a determination of whether their internal structure is ethically potent.

Material Goods Themselves

One school of thought has it that material goods are used to mark and enforce class distinctions (Veblen 1992, Douglas and Isherwood 1979, Schor 1998). Though this is certainly true and morally troubling, it reveals little about the specific quality of goods produced by modern technology. Horses, servants, and mansions were used to signal high status prior to the Industrial Revolution, and sumptuary laws were used to enforce class distinctions more rigorously than even Ferraris do in the early 2000s. Here again a cue may be taken from Marx or at least from his progeny. Like Marx, more recent left-liberal theorists have examined the transformation things undergo when they are drawn into market. Commodification is the term used to name this phenomenon, and the term carries connotations of disapproval, unlike the coreferential term that conservatives prefer, namely, privatization, or the term of mixed connotations, namely, commercialization.

Commodification has a clean and crisp economic definition: the process of moving something into the market—from either the intimate sphere or the public sphere—so that it becomes available for sale and purchase. In the case of a good from the public sphere, a public good is converted into a commodity, and, speaking more precisely, privatization is commodification in this latter sense only. Some of the public goods, such as justice and elementary education, are not material, of course, but others, such as transportation or a healthy environment, clearly are. The same distinction applies to intimate goods. Friendship and freedom are not material goods, but food and clothing are.

Commodification of intangible goods is morally objectionable because in this case a good commodified becomes a good corrupted. Justice bought is no longer justice, and friendship paid for is not real friendship. But no such opprobrium seems to taint tangible goods. Railroads are managed as public goods by governments in some countries, whereas in others they are private enterprises run for profit. Food and clothing have left the intimate sphere of the household so long ago that people no longer notice their peculiarities as commodities. Accordingly, Michael Walzer (1983), who has thought deeply about commodification (though he does not use the word), has drawn up a list of never-to-be-commodified goods, all of which are intangible.

Is there a way of capturing the apprehensions about consumerism, the suspicion that commodification of material goods is a process whereby "all that is holy is profaned" or that at least some holy things are profaned? The sacredness of food is certainly lost when it is shelved in a supermarket. The sacredness of nature is gone when it becomes an engineered setting for the wilderness lodge in Disney World. The holiness of things, or, more prosaically, their power to engage people deeply, is lost when things are stripped of their spatial, temporal, and social contexts, when those contexts are reconstituted and concealed technological means, and when the resulting commodities are made available for sale.

Commodification, then, is a cultural as well as an economic process. These two processes largely overlap, but not entirely. The food in a supermarket is commodified both economically and culturally. A typical farmers' market is a scene of economic commodification. The food, after all, is for sale. But significant contexts are there to be experienced directly. The local market reflects its special context in the fruits and vegetables that the local soil and climate can produce. It reflects the season with the hardy stuff appearing early in the year and the more tender things not until summer. Sellers are known for their expertise in growing this or that, and they establish ties of expectations and pleasure with their customers.

Conversely, tourists whose only concern is to capture the sights and scenes with their cameras deracinate treasures, trees, and towers and make them available as videos that can be shown anywhere and any time. They commodify their travels culturally though rarely economically. The things on those videos are severed from their here and now, but few would pay to see those desiccated things.

What is driving commodification? In its economic aspect it is certainly propelled by the pursuit of prosperity. This is a creditable desire, and many are grateful beneficiaries of at least some important parts of this affluence. The less noticed kinetic force of commodification is the desire for liberty—less noticed because one tends to think of liberty exclusively as political, the freedom from the oppression by persons. But, prior to the Industrial Revolution, there were also burdens and claims of material reality: the need to shear, card, and spin wool, and knit it into sweaters; the need to plant, water, weed, harvest, clean, prepare, and cook beans; and so on. Commodification, taken culturally, disburdens people of these requirements, and consumption can be taken in a culturally corresponding sense as the unencumbered enjoyment of commodities. Dematerialization turns out to be a consistent tendency of commodification. The less materially heavy and imposing commodities are, the more variously and easily they will be available and consumable. Technologically perfect virtual realities are the endpoint of this process.

Disburdenment too has its undeniable moral benefits, certainly when it comes to such basic parts of the material culture as water, warmth, and light. But disburdenment can hypertrophy from liberation to disengagement and lead to the physical and mental shapelessness that plagues the most advanced industrial societies. There is then a need to save or selectively reintroduce those material things that rightfully claim people's engagement and exertion, things such as musical instruments, gourmet kitchens, running trails, urbane cities, and more.

Morally debilitating commodification is not a problem for most people on the globe, namely, those who suffer from hunger, disease, illiteracy, and confinement. Appropriate globalizing of commodification is morally desirable. But finding a measure for appropriate globalization and for the readjustment of the material culture requires understanding the cultural and moral aspects of commodification. It is hard, however, to meet this task when science and technology are conceptually fused or rather confused into technoscience. Consider genetics. There are things to be found out about how genes and proteins relate to one another and how genes cooperate with one another and with environmental conditions to help produce brains, dispositions, and behavior. To come to understand these things is progress, and once clearly understood, the resulting knowledge compels assent. But there is nothing obviously progressive or compelling in the application of such knowledge. The eradication of aging and a massive deferral of dying may not be progress at all, and nothing compels one to think of those goals as desirable. These are moral issues that call for wisdom and persuasion.

ALBERT BORGMANN

SEE ALSO *Consumerism; Distance; Place.*

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MATERIALISM

Materialism is a term with both metaphysical and social meanings. As a metaphysical position materialism regards matter (Latin *materia*) as the primary or most real substance. In modern times materialism also has taken practical forms. Because science studies empirical objects and because material entities are more perceptible than are immaterial ones, the scientific worldview tends to assume materialism at least for heuristic purposes or on provisional grounds. Moreover, modern technological progress, especially in its early phases, provided mostly material improvements. Thus, one effect that technology seems to have had on culture is the creation of social forms of materialism such as consumerism.

Metaphysical Materialism

As a form of metaphysical monism, materialism attempts to reduce all phenomena to a single basic substance: matter. Thus, the opposites of metaphysical materialism are doctrines such as spiritualism, which holds that spirit is the ultimate reality; idealism, which sees the phenomenal world and matter as creations of the mind; and immaterialism, which rejects the reality of matter itself.

The idea of materialism was present when ancient Greek philosophy originated with Ionian natural philosophers who began to explain phenomena by referring to natural causes instead of religious myths in the sixth century B.C.E. The first systematically materialistic philosophers were the atomists Democritus and Leucippus of Abdera in the fifth century B.C.E. Among the major schools of philosophy in antiquity, Epicureanism professed materialism. In the modern period important materialists have included Pierre Gassendi (1592–1655), Thomas Hobbes (1588–1672), Heinrich Dietrich d'Holbach (1723–1789), Karl Marx (1818–1883), and Friedrich Engels (1820–1895).

One important difference between premodern and modern materialism is that the former tended to promote acceptance of the state of affairs in the world, whereas the latter is used to promote human action to change the world. Marxist materialism strongly illustrates the modern version of materialism. Indeed, Marx and Engels's philosophy developed in the former socialist countries into what was called dialectical materialism. It was materialism in the sense that it strictly denied the existence of immaterial entities, arguing that, for example, religious beliefs were part of a false ideology. The word *dialectical* referred to the quality of the laws that govern transformations in nature, history, and the human mind. Dialectical materialism saw these laws as based on the interplay of opposites.

Science, Materialism, and Ethics

Because science in principle does not make metaphysical commitments, science is not materialistic in the strict sense of the word. In fact, a more proper term for describing the way science perceives reality is *naturalistic*. The progress of modern natural science, however, has made materialism a more creditable stance than it was previously. Science studies phenomena that can be experimented on or otherwise brought to the impartial attention of the community of scientists. Clearly immaterial things such as the soul, supernatural events, values, ideals, and meanings are difficult or impossible to research scientifically. Thus, it seems from a scientific perspective that things one cannot examine scientifically are not real.

In practical life and in the adaptation of science the tendency toward materialism is manifested, for instance, in measuring. Measuring is essential in all science-related activities because exact scientific research is based on calculating measured quantities. An object of science must be measurable in some sense. Hence, it is difficult to do scientific research on phenomena in their qualitative aspects. For example, a scientist easily can determine the weight, size, and age of an ancient Chinese vase, but it is impossible to specify scientifically its degree of beauty. In consequence, quantity appears to be "more real" category than quality.

In ethics the success of natural science has had both implicit and explicit consequences. The most explicit consequence was the logical positivist argument in the 1920s that ethics is a merely emotional use of language that lacks empirical content. Although this extreme view soon softened, ethics nevertheless struggled throughout much of the twentieth century against the tendency in a culture dominated by science to perceive reality as being defined by the possible objects of science. For instance, medicine can study whether smoking harms health, but it is a value question whether harming health is wrong. The only scientific approaches to value in this sense appear to consist of empirical research on expressed preferences or arguments for the evolutionary development of certain behaviors. Because values, norms, and ideals in the normative sense—moral sociology is another question—are not objects of scientific inquiry, ethics as a rational pursuit has had a credibility problem.

Technology and Materialistic Culture

Until recently technological advancement has contributed mainly to the improvement of the material conditions of life. This has meant highly increased material well-being for the majority of the people in industrialized societies.

According to some cultural critics, however, this development has not been free of malaise. It appears to those critics that human life has lost some of its dignity in the course of material success. This lack of dignity has been pointed out in consumerism, the loss of traditional skills, the sacrifice of ideals in the search for economic profit and quick satisfaction, and so on. Culture itself has been turned into a commodity to be mass produced and marketed industrially. The rule of quantity over quality in social and political life often is expressed in attitudes that make money and financial success the final arbiters of the good.

Some analyses of contemporary culture have suggested that classical Western ethics is incapable of addressing current issues because it does not pay sufficient attention to the material culture, that is, the production and use of material goods. At the heart of such criticisms is the notion of alienation. Cultural critics are afraid that the materialistic mass culture estranges human beings from themselves, other people, and nature. When it comes to nature, ecological problems are the most pressing issues related to materialistic consumerism.

Immateriality in Science and Technology

However, science and technology also have crucial immaterial aspects. Mathematics is indispensable for science, and mathematical abstractions are clearly immaterial. Moreover, science attempts to find regular patterns in reality and to form lawlike theories to describe those patterns. The structures, laws, and theories that science develops while investigating material reality are all immaterial. In this sense the object of science is material phenomena but the results of research are immaterial concepts that give new meanings to material reality. This is especially true in the most recently developed fields in science, such as computer science, genome studies, and neurological research.

Science can ask the question "What is matter?" but its answers are extremely complex and theoretical. Matter appears to consist mostly of empty space between elementary particles. Modern physics thus challenges any idea of matter "in itself" because what can be known about matter in the early twenty-first century is eminently theoretical and experiment-dependent.

In the realm technology information technologies and nanotechnology, which are highly theory-based forms of technology, deal mostly with immaterial phenomena. Generally speaking, technology can be interpreted as making matter less significant for human beings. For instance, communication and transportation technologies have made the globe "smaller" and reduced the role of time and place, which form the ultimate framework for matter, in human life. In this sense technology has made matter "serve" humankind.

Some essential immaterial aspects can be found in production as well. The emphasis of the economic structure in advanced societies has moved increasingly toward the production of immaterial services and information processing. Furthermore, in designing and marketing material commodities, aesthetic values, symbols, concepts, and myths form something that is now called a "brand." More and more companies do not sell only a material product but market an idea and a lifestyle. One does not buy a cell phone, one buys a successful person's phone.

These transformations in the economic structure and the style of production have been referred to as dematerialization. This term denotes the reduction of material used to produce specific goods and services. Dematerialization has raised hopes that economic growth and ecological sustainability may be reconciled so that consumers characteristically will purchase functions rather than material objects.

These reflections indicate how materialism is an ambivalent issue for science, technology, and ethics. Techno-scientific development has passed through a phase of studying and molding material reality, but currently the most important fronts in science and technology involve work on largely immaterial phenomena.

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SEE ALSO *Consumerism; Dematerialization; Material Culture; Two Cultures.*

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McCLINTOCK, BARBARA

Nobel Prize-winning geneticist Barbara McClintock (1902–1992) was born in Hartford, Connecticut on June 16, and earned a doctorate in botany at Cornell University in 1927. Her early work on maize cytogenetics in R. A. Emerson's group at Cornell University in the 1920s and 1930s (where she worked with Marcus Rhoades, George Beadle, Harriet Creighton, Charles Burnham, and others) provided crucial evidence for the chromosomal basis of genetic crossover. Later, McClintock moved to the Cold Spring Harbor Laboratory in New York where she continued her groundbreaking research in genetics. But of her many achievements, her work on genetic transposition stands out as the most revolutionary. This work, establishing the mobility of genetic elements, defied conventional assumptions of the fixity of genes on the chromosomes and went unheeded for many years by most geneticists. But in 1983, thirty-two years after her first definitive paper on the subject, she was awarded the Nobel Prize for Physiology and Medicine, and her vindication was complete. After a lifetime pattern of relative obscurity and isolation, this prize ushered in a period of widespread public recognition—recognition not only for the quality of her work, but also for the model of scientific research she both advocated and exemplified. In her own words, good scientific research needed to be premised on "a feeling for the organism." She died near Cold Spring Harbor on September 2.

Barbara McClintock, 1902–1992. American geneticist McClintock received the Nobel Prize in Physiology for her discovery that genes could move from place to place on a chromosome. *(AP/Wide World Photos.)*

McClintock is of particular interest to historians of biology for her success in breaking with tradition on a number of fronts: as a geneticist whose understanding of genes was shaped by her interests in development; as a woman who refused to be constrained by conventional notions of gender; as a scientist who dared to affirm the importance of cultivating an intimate relation to the object of one's study in the rational construction of knowledge. For her, understanding a plant requires following it from its beginning: "I don't feel I really know the story if I don't watch the plant all the way along. So I know every plant in the field. I know them intimately, and I find it a great pleasure to know them" (Keller 1983, p. 198). But McClintock has also become a controversial figure, largely owing to differences in perspective between the two biographies that have been published (Keller 1983, Comfort 2001). Controversy centers largely on two issues: first, the extent to which her early work on transposition was in fact neglected; and second, on whether or not her particular methodological style can be taken as representative of either a "feminine" or a "feminist" approach to science.

Perceptions of neglect and recognition are inevitably at least partly subjective. Certainly, McClintock felt her work to be neglected, or at best, misunderstood. Equally certainly, many colleagues held her in enormously high regard. Nevertheless, prior to her Nobel Prize, and even after the rediscovery of transposition in the mid-1970s (under the name "jumping genes"), the phenomenon was widely regarded as of marginal significance to the general processes of genetics and development. Furthermore, interviews conducted prior to 1983 provide strong support for a fairly widespread tendency, perhaps especially among molecular biologists, to regard her and her work as eccentric curiosities. After 1983, however, a sea change could be seen to take place.

As a Nobel Laureate, McClintock suddenly became a heroine with whom virtually everyone wished to be identified, including feminists and mainstream scientists. Indeed, it was only at this point that McClintock began to be perceived as a feminist heroine, and that Keller's book (published some months before the prize) began to be read as a feminist manifest. Both readings fly in the face of the evidence—evidence provided both by McClintock's life and by Keller's biography. Comfort's biography goes some way toward correcting the record, and in deflating the "McClintock myth." Unfortunately, in the process he may have unwittingly contributed to the creation of a new myth, making of McClintock too much a practitioner of "normal science," and one who now appears to have been more fully embraced by the community around her than the historical record suggests. However, the scientific community's celebration of McClintock after 1983 is evident, and attested to by numerous publications (such as, for example, the excellent overview of her work by Federoff and Botstein 1992).

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SEE ALSO *Genetic Research and Technology; Sex and Gender.*

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McLUHAN, MARSHALL

Herbert Marshall McLuhan (1911–1980) spent nearly all of his life in Canada. Born in Edmonton on July 21, he was raised in Winnipeg and developed an early interest in engineering. There, he earned an M.A. in English, then went to Cambridge University and received additional B.A. and M.A. degrees, and also a Ph.D. (English). A widely published author of more than thirty books, one of which has been translated into more than twenty-five languages, McLuhan taught for three decades at the University of Toronto and died in Toronto on December 31.

McLuhan virtually invented the field of media studies and its relation to culture and society. McLuhan argued that the initial content of any new medium is always a preexisting medium (so radio, for example, takes over from the music hall and the newspaper; TV subsumes radio drama and film; and so on), so that the study of how a medium is used reveals little or nothing about its formal character or effects. Content study invariably leads to moral declaration and away from knowledge of the new form. Each major new medium means a new culture, and often a new war (McLuhan and Fiore 1968). For McLuhan the usual "moralistic" approach to media matters was incapable of producing real insight into the working of media as potent cultural forms.

Works and Insights

His groundbreaking *Understanding Media: The Extensions of Man* (1964) was the first to examine the effects of technologies of communication on shaping the culture and sensibility of the users. Ralph Waldo Emerson (1803–1882) had observed, "The human body is the magazine of inventions, the patent-office, where are the models from which every hint was taken. All the tools and engines on earth are only extensions of its limbs and senses" (1870). This was a key to McLuhan's insight into human artifacts. McLuhan thus pioneered the study of the human senses as they are extended and modified by old and new media alike. *The Gutenberg Galaxy* (1962) details the impact of the printing press on late-medieval European sensibility and how it brought about the Renaissance. Later works traced the effects of electric technologies, beginning with the telegraph, in dissolving print culture and literacy and instituting a new kind of tribal mentality that extends worldwide. Although he approached the study of media by observation and analysis, the major criticism leveled at his work was that it was "not scientific."

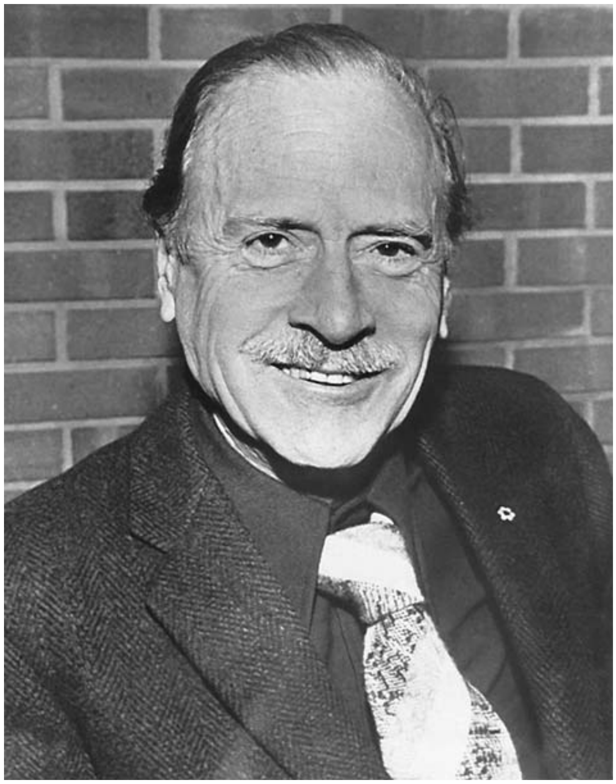
In posthumous works such as *Laws of Media: The New Science* (with Eric McLuhan; 1988) and *The Global Village* (with Bruce R. Powers; 1989), McLuhan synthesized his major discoveries and identified four scientific laws that govern the action of all human artifacts: amplification, obsolescence, reversal, and retrieval. He explored how his work integrated and updated the work of Francis Bacon (*Novem Organum*) and Giambattista Vico (*The New Science*).

McLuhan had a facility for aphorism, encapsulating a complex process in a memorable phrase such as "The medium is the message." He went to great lengths to point out that each medium, independent of the content it mediates, has its own intrinsic effects that are its unique message.

> The message of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs. The railway did not introduce movement or transportation or wheel or road into human society, but it accelerated and enlarged the scale of previous human functions, creating totally new kinds of cities and new kinds of work and leisure. This happened whether the railway functioned in a tropical or northern environment, and is quite independent of the freight or content of the railway medium (McLuhan 1964, p. 8).

What he writes about the railroad applies with equal validity to the media of print, television, computers, and now the Internet. "The medium is the message" because it is the "medium that shapes and controls the scale and form of human association and action" (p. 9).

Another McLuhan term that has entered common usage is "the global village." In *Understanding Media* he wrote, "since the inception of the telegraph and radio, the globe has contracted, spatially, into a single large village. Tribalism is our only resource since the electromagnetic discovery. Moving from print to electronic media we have given up an eye for an ear" (pp. xii–xiii). The "global village," which many now see forming as a result of the Internet, was a side effect of the telegraph and of radio.



Marshall McLuhan, 1911–1980. A Canadian professor of literature and culture, McLuhan developed a theory of media and human development claiming that "the medium is the message." *(© Bettmann/Corbis.)*

Influences On and From

McLuhan's work absorbed influences from prior work on the social and cultural impact of communications technology by Harold Innis (1894–1952) and others in the arts. In integrating and extending such perspectives, McLuhan created a distinctive approach to media studies often erroneously described as emphasizing a kind of technological determinism with rhetorical excess. In reality, however, McLuhan was simply pointing out how certain technologies influence the world so that their users could learn to control them.

After a decline in reputation during his later years and soon after his death, McLuhan was rediscovered in the 1990s, and his insights into media found new application in interpreting twenty-first-century global communications developments. Among those who have taken up the study of technologies and culture, McLuhan offers one of the more comprehensive and consistent explanations for the welter of changes that accompany science and technology—changes that include new challenges for ethics and politics. Although some scholars continue to dismiss him as a maverick, he has been welcomed by pioneers in digital communications such as those associated with *Wired* magazine (founded 1993). Moreover, philosopher and media theorist Paul Levinson (1997) has drawn connections between McLuhan and the evolutionary epistemologies of Karl Popper (1902–1994) and Donald T. Campbell (1916–1996), both of which have ethical dimensions.

ERIC McLUHAN

SEE ALSO *Internet; Science, Technology, and Society Studies; Television.*

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MEAD, MARGARET

The most celebrated anthropologist of the twentieth century, Margaret Mead (1901–1978) was born in Philadelphia, Pennsylvania on December 16, and died in New York City on November 15. Her career began with a shift from psychology when Ruth Benedict (1887–1948) and Franz Boas (1858–1942), two of her teachers at Columbia, attracted her with Benedict's challenge that they had "nothing to offer but an opportunity to do work that matters." Bridging these two fields, Mead became a founder of the culture and personality school of anthropology; she was deeply committed to making anthropological knowledge matter—especially in a world of rapid scientific and technological change.

Mead's career took off when she went to Samoa at age twenty-three to study adolescent girls and to explore whether the emotional strains of adolescence were uniform across cultures or varied depending on socialization and experience. This led to her first book, *Coming of Age in Samoa* (1928), a bestseller that gave many readers their first awareness that their assumptions about human behavior might not always apply. Although this book was caricatured and attacked by the anthropologist Derek Freeman in 1983, twenty years of debate has affirmed her descriptions, showing that Freeman's insistence on the biological determination of variations observed fifty years after Mead's work in other areas of Samoa supplemented but could not refute Mead's basic emphasis on learned—and therefore potentially variable—behavior.

Mead's subsequent fieldwork up until World War II took her to four different New Guinea societies and to the Omaha tribe of Nebraska with her second husband, Reo Fortune, and then to Bali and another New Guinea society, the Iatmul, with her third husband, the anthropologist and ecological thinker Gregory Bateson. During this period, she focused primarily on child rearing and personality development and secondarily on gender differences, where she pioneered the comparative study of gender roles. Her work appeared both in further trade books such as *Sex and Temperament in Three Primitive Societies* (1935) and in detailed technical monographs such as *The Mountain Arapesh* (published in three parts, 1938–1949), establishing the pattern of applying her findings in the field to the dilemmas of industrialized society, and writing in several genres for different audiences. She also innovated in methodology, beginning the use of projective tests in fieldwork and, with Bateson, invented a new technique of visual anthropology exemplified in *Balinese Character* (1942). Her fieldwork archives are available at the Library of Congress.

World War II led Mead and other social scientists to focus on industrialized nations as part of the war effort. Mead collaborated with Benedict in developing the application of anthropology to contemporary cultures made inaccessible by war and political conflict, primarily through the Columbia University Research in Contemporary Cultures project. This methodology, described in *The Study of Culture at a Distance* (1953), which led to multiple publications by many authors, involved the creation of interdisciplinary and intercultural teams not unlike contemporary focus groups, and the analysis of literary and artistic materials in ways that anticipated contemporary cultural studies. Mead founded the Institute for Intercultural Studies in New York in 1944 to house these projects and a variety of later activities.

The war had precipitated rapid and often devastating culture change, and Mead's postwar focus was on change, particularly the possibilities of purposive culture change. In 1953 she returned to Pere, a Manus village in the Admiralty Islands (now part of Papua New

Guinea) she had studied with Fortune, to analyze the effects of the war on a community with little previous outside contact. In Manus, she found that a charismatic leader had promoted the choice of integration into the outside world and the villagers were positive about change rather than demoralized by it; that rapid change is sometimes preferable to gradual change; and that children could play a key transformative role (Mead 1956). Mead was one of those who introduced the concept of "culture" into the thinking of readers, with profound intellectual and ethical results, but her emphasis on purposive culture change reaffirmed ethical issues avoided by some cultural relativists, and she insisted that many human institutions, such as those of warfare and racism, be seen as human inventions that could be modified or replaced, rather than as "natural" and unavoidable. Her understanding of the role of individuals and groups in the remaking of Manus society was key to her book *Continuities in Cultural Evolution* (1964), best summarized in her often quoted phrase, "Never doubt that a small group of thoughtful committed citizens can change the world."

Mead believed that the understanding of cultural diversity offered a new kind of freedom to human societies, and she worked tirelessly and skillfully to disseminate anthropological ideas, lectured widely, published profusely, and was quick to understand the possibilities of new media. Unlike many academics, she saw communicating to the public as a professional obligation of comparable intellectual integrity to her more narrow professional writing. She also taught for many years at Columbia University and the New School for Social Research. At the same time, Mead worked with colleagues in other fields who kept her close to new developments in biology and neurology. She was an active member of the Macy Conferences on Cybernetics and on Group Process in the postwar period and of the World Federation for Mental Health. She was associated for more than fifty years with the American Museum of Natural History, serving in her later years as its Curator of Ethnology. She served as president of the American Association for the Advancement of Science and the American Anthropological Association, and was a founder of the Scientists' Institute for Public Information. She received twenty-eight honorary degrees, more than forty academic and scientific awards, and was awarded the Presidential Medal of Freedom following her death in 1978.

MARY CATHERINE BATESON

SEE ALSO *Cultural Lag; Modernization.*

Margaret Mead, 1901–1978. An American anthropologist, Mead developed the field of culture and personality research and was a dominant influence in introducing the concept of culture into education, medicine, and public policy. *(AP/Wide World Photos.)*

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MEDICAL ETHICS

Medical ethics is the most prominent branch of the broader field of bioethics. In general, medical ethics concerns itself with issues arising in the relationship between a health care professional, primarily a physician, and a specific patient. To a lesser extent medical ethics is concerned with issues of justice and equity in the delivery of and access to medical care.

Three sets of issues have dominated the discussion of medical ethics as a discipline since the 1960s. Each of these sets of questions has been decisively influenced by the development of modern medical science and technology. In fact, it can be argued that if not for the advances in medical technology between the early decades of the nineteenth century and the first half of the twentieth century, medical ethics as the discipline it currently is simply would not exist.

Doctor and Patient

The first set of issues of decisive interest in medical ethics are those having to do directly with the relationship between the physician (or other professional) and the patient. The most important of these concerns is that having to do with the informed consent of the patient to medical interventions. In the discussion of medical ethics since World War II the principle of informed consent has achieved universal, canonical status. One may not provide any care to otherwise competent patients without first explaining the situation and the options and securing patient agreement to proceed. This principle was first enshrined in medicine after World War II when the abuses of Nazi doctors in so called "experiments" came to light. The Nuremberg Code, formulated at the famous war crimes trial, enunciated the principle for researchers clearly: *The voluntary consent of the human subject is essential.* Later, in the 1960s, when it was discovered that some American physicians were ignoring this principle, renewed emphasis was placed on it in law and medicine.

The very emergence of this bedrock principle has been decisively shaped by technology. Prior to the twentieth century little could be done to actually treat most forms of illness and disease. What could be done required the active involvement of patients both in telling the doctor their symptoms, and their stories (travel, diet, lifestyle, etc.), and in following a therapeutic regimen of diet, rest, fluids, or other recommendations. An unconscious or unwilling patient would not reveal much nor cooperate in therapy. Pedro Laín Entralgo (1908–2001), the great medical historian of the premodern period, aptly called Greco-Roman medicine the "therapy of the word" in which the spoken word was crucial to diagnosis and treatment.

Consider now a patient who is brought unconscious into a twenty-first-century emergency room. The stethoscope can alert the physician to heart or lung problems, and scanning technology can reveal the presence of various brain injuries such as blood clots or strokes. Further scannings and laboratory techniques can reveal the precise source of problems from heart infections and heart attacks to pneumonia or drug abuse. Broken ankles and sprained ankles can be differentiated with technology, as can warts and melanoma.

Treatment can likewise be provided even if the patient refuses. Surgery, which is dominated by technologies, is performed on an anesthetized patient, not a conscious one. Prisoners can be treated for infectious diseases whether they wish it or not in the name of prison safety. Intravenous medication and hydration can be provided to the unconscious or the unwilling. Thus, the modern insistence on informed consent as a moral principle makes sense only in a world in which technology has decisively objectified the patient in the physician's hands and made possible medical care without patient involvement.

The same may be said of the importance of patient competency in contemporary medical care. The concept of competency is highly complex. The general idea is that in order for informed consent to be required patients must be capable of comprehending their medical situation and making choices about it. But competency is crucial only if one can, with technology, offer plausibly beneficial therapy to patients who are not competent. Competency and the associated questions regarding who should make decisions when patients cannot (for example, physicians, families, courts, committees) becomes a serious issue only when treatment is possible without the interpersonal word passing between doctor and patient. When therapies of the word are the only therapies possible, then any therapy presumes that the patient is plausibly competent. It is only when therapies of impersonal technology have surpassed therapies of the word that competency becomes an essential focus.

Technology has also profoundly altered the context in which one of the oldest principles of medical ethics, confidentiality, is viewed and defended. Though enshrined as early as the fourth century B.C.E. in the celebrated Hippocratic oath, and in the latest code from the American Medical Association, this concept has been decisively pressured if not altered by modern technology in three important ways. First, the early-twentieth-century growth of complicated technology such as clinical laboratories and X-ray machines caused a centralization of medical services in the modern hospital. Doctor's offices became appendages of the hospital often physically connected by tunnels or walkways. Records once kept confidential in a physician's office became centralized in the hospital and available for many more to see.

Second, technology led to increasing specialization both in medicine itself and in allied fields such as nursing, laboratory technology, physical and respiratory therapy, and more. Each of these specialists, from cardiac surgeons to cardiac rehabilitation technologists, has a legitimate need for access to a medical record both to document their care and to see what other care has been given. Thus, gone are the days of a specific private communication between two and only two persons: physician and patient. Now anonymous lab technologists who have just met a patient will know, and arguably need to know, that the patient from whom they are drawing blood has, for example, a bloodborne disease such as AIDS.

Third, advanced information technologies have become a standard way for storing information. They provide the most efficient means of data storage and retrieval both in hospital and out. The idea is that if a patient is brought to an emergency room thousands of miles from home the emergency room staff can have nearly instantaneous access to a patient's medical history, which they need to know to provide adequate care. But the very promise of easy access to sensitive information for professionals also suggests easy access for those with no need to know: reporters, hackers, angry relatives, titillated billing clerks, and nosy neighbors.

Life and Death

The second great set of issues in medical ethics are those having to do with the beginning and ending of life: abortion and the variety of issues dealing with euthanasia. Abortion has been an issue within medicine since Greco-Roman times. The Greek physician Soranus (second century C.E.), author of the first gynecological textbook, describes methods of producing abortion and then proceeds to criticize abortion for "cosmetic" reasons (for what he regarded as reasons of personal comfort or vanity, such as the fact that pregnancy altered one's looks or figure).

Though abortion has been a staple of medical ethics since, modern science and technology have decisively altered debates about the morality of abortion. It is often said that "science" believes or has "proven" that life starts at conception. Though technically correct now, the beginning of life at conception was discovered only in the early nineteenth century. Furthermore, contrary to the wishes of those who often make this claim, the claim itself does not lead to a moral conclusion unless one adds a moral principle such as "all human life of whatever sort should be preserved." Whether such a principle is sound is widely debated, but something like it must be added to the embryological claim to lead to a moral conclusion about abortion.

Furthermore, some of the most contested issues about selective abortion and partial-birth abortion exist only because of advances in medical technology. It was only in the late 1960s that the first process of prenatal diagnosis, amniocentesis, was developed to diagnose fetuses with chromosomal abnormalities such as trisomy 21 (Down syndrome), trisomy 18 or 13, fragile X syndrome, or broken chromosomes. In the early 1980s sonography (ultrasound) and blood screening technology advanced to the point that it could reliably diagnose in utero the second most common birth defect, spina bifida. In the future scientists hope to move beyond analysis of chromosomal abnormalities to genotyping of specific genetic abnormalities such as those that cause a variety of ills from blindness and Huntington's chorea to vaguer conditions such as tendencies to substance abuse and depression. To a limited extent this is already done in fertility clinics with preimplantation genetic diagnosis. Whatever the outcome, the issue of abortion for reasons of parental deselection of undesirable characteristics would not exist except for the technology that allows for the identification of such characteristics and the safe abortion of second-trimester fetuses or the existence of fertility clinics.

The same influence of technology is evident in the much contested situation of "partial-birth" abortions and/or very late term abortions. It is only because of advanced medical technology that late-term abortions are relatively safe, so the morality of taking the life of those fast approaching birth becomes an issue. Before the relatively recent past, abortion of any sort was preformed only infrequently because it was simply medically too dangerous for the woman.

The second cluster of life and death issues, those having to do with end-of-life care, have been even more decisively shaped by technological change. The first of these issues, that concerning the concept of death, would not exist but for the advancement of technology. Before the middle decades of the twentieth century the legal and moral definition of death was simple: complete and irreversible cessation of vital signs, specifically heartbeat and respiration. Physicians routinely called a person dead when the vital signs had ceased for a period of time that made them irreversible. In the 1950s technology decisively altered this framework. Respirator technology could pump air into a patient's lungs, forcing them out and weakly pumping blood to the heart and the body. Vital signs might never stop, and even the permanently unconscious might never "die." Technology seemed to promise longevity even to those whose conscious life had ended.

In this context, medicine and society were compelled to develop new understandings of death. Thus came the well-known concept of "brain death" in which persons could be considered brain dead if certain brain activities had ceased, even though other vital signs were artificially maintained. A debate has followed over different conceptions of brain death—centering on a cautionary "whole brain" formulation versus a broader "higher brain" formulation—but the important point here is that such a debate would not exist were it not for respirators, feeding tubes, and intravenous hydration and antibiotics that allow persistently unconscious human bodies to be kept alive indefinitely.

The same technological revolution brought out the importance of many other issues surrounding end-of-life care. How aggressive of an approach should be taken in keeping individuals alive who are gravely or terminally ill or severely brain damaged? The question of whether to go to extraordinary lengths to keep persons alive with advanced Alzheimer's disease or other brain deterioration is different from whether a doctor can just declare them dead. These questions have become crucial questions of end-of-life care. They become questions, however, only if there is a possibility of aggressive treatment of those who are gravely ill or severely handicapped. The morality of prolonging the life of the critically ill with technology becomes an issue only when the technology exists, such as respirators or dialysis machines, that will help preserve life.

A similar question involves when to resuscitate or not to resuscitate a patient who goes into cardiac arrest. Of course, one resuscitates in the emergency room and in cases of simple cardiac arrest in otherwise healthy persons. Furthermore, if patients have stated their wishes to be resuscitated, one honors them. But most hospitalized patients have never let their wishes be known. Should gravely ill persons in the intensive care unit routinely be revived even though data shows that such patients have very poor outcomes? The issue is widely debated, but the debate follows only from the existence of resuscitation technology such as defibrillators and heart-stimulating drugs.

So also does the agonizing debate since the 1970s about treatment for critically ill newborns follow from the advance of technology. Critically ill newborns may be saved with extensive interventions. But they may be left with severe handicaps as a result of many deficits. Parents and physicians are left with serious questions about when to intervene to save the life of such infants. Questions about the sanctity of all life, the quality of life, and when if ever life itself is not worth living swirl around these cases. Agonizing moral and legal debates both at the individual and policy levels have been involved. The debates, however, follow only from the dramatic advances in medical technologies that allow evermore fragile newborns to be saved.

Though issues of euthanasia and physician-assisted suicide have been around for millennia, as witnessed by the condemnation of euthanasia in the Hippocratic oath, they have taken decisive new turns in the modern period with the development of pharmacological means of causing death relatively painlessly and with a high degree of certainty. When suicide was limited to guns, knives, and poisons, the pain of the act was a deterrent. But when an injection of morphine and potassium chloride from a physician will end life quickly and painlessly, the issue takes on new dimensions. The same is true of the contested issues of physician-assisted suicide where doctors provide the means and patients take the action. This is hardly an issue when a person can buy a gun or rat poison at a hardware store. But with the advent of modern pharmacology, physicians can provide their terminally ill patients with strong painkillers such as Demerol and verbal instructions to enhance the power and speed with whiskey. Patients will then go unconscious and die without much suffering. Technology enhances the question: Should doctors ever do this?

Justice and Distribution

The third and final set of issues that has dominated the field of medical ethics in the last generation has been those related to access to and distribution of health care. One subset of issues here has to do with access to scarce lifesaving technology. In the early 1960s it was the development of dialysis, in the early twenty-first century it is organs for transplant. In the future it is likely to be new genetic technologies. Technologies change but issues of equitable access continue.

Basically there have been two broad contenders: (a) a merit-based selection or deselection scheme or (b) some form of randomization. Merit schemes are intuitively appealing but notoriously difficult to practice. Who is not moved by the plight of a mother of young children who needs a liver? Better she get it than a fifty-year-old who has grown children. Or who is not adversely affected by the thought of giving a liver transplant to someone, even as famous as the New York Yankees baseball star Mickey Mantle, who needed a new liver because drinking destroyed his original one? Though appealing, criteria of social worth are notoriously slippery. Perhaps Mantle stopped drinking years ago. Is he now to be thought of as less meritorious because of what he did as a younger person? Perhaps the fifty-year-old has a handicapped grandchild and her child care is much needed. Once carefully thought through, it seems that most people have merits and demerits in their lives. No one is so stellar that their case for new organs or other technologies shines clearly above the rest. Nor is anyone so completely unworthy that they can make no reasonable claim on a scarce medical resource.

Such considerations have led many to support some kind of randomization as a means of selection. The most common, especially in the case of transplants, is first come first served. In the case of transplants, patients are first screened medically to see if they are candidates for surgery—for example: Do they need a transplant? Could they survive such major surgery? And so on. Then they are broadly ranked according to medical need: How soon would they die without surgery? Finally, they wait their turn. When an organ becomes available that is tissue compatible, the person at the top of the list goes first. Though common this is not the only random method discussed in the literature. For example, though not often used, a lottery would be just as random and may have other advantages such as giving every needy person an equal opportunity to be served.

Finally the discussion of medical ethics has focused intensely on the question of whether there is a "right to health care" and if so how best to provide access to health care to those without it. It is now widely held that a society should provide basic medical care to all. Once this is granted two problems remain. First, how should the range of services to be provided be determined? Should services for some or all citizens be cut to free resources for those who do not have access? Plastic surgery might be an obvious cut, but what about expensive surgery that has very limited chances of success, such as treatment for some forms of cancer? For the person who needs the treatment as their only hope of survival, the question is answered one way. For the rest of society trying to find resources to provide prenatal care for poor women, the question might be answered differently.

Though this problem is difficult, a second sort of discussion has centered around how to provide access to basic services. Two broad approaches have dominated the discussion. The first is a government-run system in which doctors are paid by the government and tax revenues are used to provide health care for everyone. The second is to use tax revenues to move those without care into private health care plans. Each approach has its own difficulties. Government-run plans are often overused for minor problems and can result in long waiting lines for needed care. Private insurers can become bankrupt when they enroll too many sick persons at low rates. The problems are only compounded by the development of new technologies that increase the cost of health care in general.

For present purposes the most important points concern questions of access that follow advances in medical technology. One cannot talk about rationing access to dialysis or organ transplants until there are dialysis machines or transplant capabilities. Like other issues, this one too has been decisively shaped by the advances of medical technology.

Assessment

Medical ethics is representative of a larger field of professional and applied ethics in two important ways. First medical ethics involves the application of generally recognized principles in specific social, economic, and cultural settings. All cultures place a very high value on human life. But how that is balanced against quality of life and the use of scarce resources may vary in different settings. In a wealthy country such as the United States keeping someone alive at great expense may look very different than the use of scarce resources on a single life may look in a poor country with many public health needs. High technology may be afforded in one country but where even low technology is socially expensive the choices are much different.

Secondly, medical ethics combines both universal moral principles such as honesty and integrity with intra-profession principles or norms that are unique to that profession. Empathy is a highly valued virtue in medicine and less so in other professions such as engineering. Empathy is also a decisive virtue in modern times when technology can so easily separate doctor and patient. At other times such a virtue may require less effort.

Medical ethics, like medicine itself, has been profoundly shaped by modern science and technology. Without technology, the moral choices will look very different. However, without guidance from general principles such as respect for life and liberty technology may challenge the profession in uncharted ways.

RICHARD SHERLOCK

SEE ALSO *Abortion; Acupuncture; Aging and Regenerative Medicine; Bioengineering Ethics; Bioethics; Brain Death; Cancer; Complementary and Alternative Medicine; Death and Dying; DES (Diethylstilbestrol) Children; Drugs; Embryonic Stem Cells; Emergent Infectious Diseases; Genethics; Health and Disease; HIV/AIDS; Persistent Vegetative State.*

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MERTON, ROBERT

American sociologist considered to be the father of the sociology of science, Robert King Merton (1910–2003) was born in Philadelphia, Pennsylvania, on July 4, and died in New York City on February 23. His scholarly career spanned more than seven decades. Merton's contribution to ethics in science and technology was his elaboration of the social, and human, nature of scientific research.

After undergraduate study at Temple University, Merton attended Harvard University. He began his doctoral thesis in 1933 and completed it two years later with the title "Sociological Aspects of Scientific Development in Seventeenth Century England." In 1938 Merton's revised thesis was published in *Osiris: Studies on the History and Philosophy of Science, and on the History of Learning and Culture* as *Science, Technology and Society in Seventeenth Century England (STS).* In this work, Merton explored the reciprocal relationships between the development of science and the religious beliefs associated with Puritanism. He concluded that cultural attributes, religious beliefs, and economic influences made it possible for science and its technical applications to flourish.

Merton later indicated that when *STS* was first published, it was generally ignored by sociologists (see Cohen 1990 and Chapter 20 by I. Bernard Cohen in Clark, Modgil, and Modgil 1990). More than three decades later, Merton's *STS* was published by a commercial publisher. By then, his reputation in sociology generally and in the sociology of science particularly was so broad that *STS* was widely studied and was considered a classic. It was both criticized and praised by historians, sociologists, and others.

After completing his doctorate, Merton taught at Harvard and published his most famous paper, "Social Structure and Anomie" (see Stephen Cole in Coser 1975). Merton's theory asserted that in the United States, people are taught to pursue the goal of economic success regardless of their location in the social structure. Yet the means to achieve success are not always available, resulting in a social condition conducive to deviant behavior.

After Harvard, Merton taught for two years at Tulane University. In 1941 he was invited to join the faculty at Columbia University; he remained affiliated with that university for the rest of his career. Soon after joining the faculty, he began to serve as associate director of the Bureau of Applied Social Research.

Merton published several articles from his thesis analyzing the social contexts of scientific advancement. In 1942, he described the normative structure of science in "Science and Technology in a Democratic Order" (reprinted in Merton 1973). He explains how the social institution of science involves a normative structure that works to support the goal of science—the extension of certified knowledge. Modern science has at least four norms or behavioral constraints that constitute its unique ethos.

Organized skepticism requires that any claim to new knowledge stand up to the same scrutiny, regardless of its source, before it becomes part of the accepted body of certified knowledge. *Universalism* requires that age, sex, race, or creed should not influence a decision about the acceptance or rejection of scientific information. Only the logical structure of the argument and the quality of the data are relevant. *Communism* (or *communality*) requires that once scientific information has been created or discovered and made public, the originator has no future intellectual claims to it. All scientists are free to use it in their work (with appropriate attribution). *Disinterestedness* requires scientists to be motivated to extend knowledge, not to seek personal gain.

This 1942 paper had a passing reference to a remark by Sir Isaac Newton stating, in effect, that if he had seen farther (in his work), it was by standing on the shoulders of giants. In the two decades that followed, Merton traced backward (and forward) the twelfth century origins of that phrase. *On the Shoulders of Giants* (1965) became a classic for its bibliographic erudition and style, and is recognized as a literary masterpiece.

Robert Merton, 1910–2003. Merton was a sociologist, educator, and internationally regarded academic statesman for sociology in contemporary research and social policy. He is considered the founder of the sociology of science. *(Archive Photos, Inc.)*

During the 1940s and 1950s, the Bureau of Applied Social Research provided unusual opportunities to collect data and conduct sociological analyses, and Merton developed a large body of theory that established his sociological talents. His new ways of seeing social realities invaded popular and official language. His work included such concepts as manifest and latent functions, self-fulfilling prophecy, goal displacement, local and cosmopolitan influentials, accumulation of advantage, the Matthew effect, theories of the middle range, sociological ambivalence, and obliteration by incorporation (Clark et al. 1990).

For two decades after Merton's 1938 contribution to the historical sociology of science, research by others in the sociology of science was largely dormant. In 1952, Merton explained why social aspects of science would be neglected by sociologists (Merton 1973). Most sociological research focuses on social problems such as deterioration of the family, political unrest, urban congestion, race relations, the media, and so on. Consequently, until either scientific knowledge or science as an institution is defined as a problem for society, scholarly investigators likely would not select science as the subject of social analysis.

In 1957, Merton's American Sociological Association presidential paper "Priorities in Scientific Discovery" continued his exploration of the developing sociology of science (reprinted in Merton 1973). That paper eventually became the most cited publication in the sociology of science (see Cole and Zuckerman's chapter in Coser 1975). It was full of ideas for further research, and provided a broad foundation for a growing interest in the sociology of science. During the 1970s, as science became to be perceived as a social problem, the number of scholars specializing in the sociology of science increased much faster than the growth of the field of sociology in general.

By the 1980s, Merton's influence was evident in the United States and in Europe. Colleges established courses and degree programs, and research centers focusing on social studies of science were created. Sociologists successfully organized specialty scholarly groups nationally and internationally. Although Merton was recruited to organize these societies, he mostly encouraged others and provided moral support.

During the last twenty years of the twentieth century, many competing ideas about the social nature of science developed. Controversies flourished about the foci of inquiries, research methodologies, and the validity of Merton's and other theories. These issues were debated internationally among historians, philosophers, sociologists, and others.

The Mertonian view of science based on the institution's normative structure was criticized as empirically invalid, especially by scholars outside sociology. Because social norms are not absolute, and compliance is rarely total, some deviance among community members is expected. Deviance among scientists, however, provided the basis for scholars to question Merton's perspective.

Merton was arguably the most influential sociologist in the twentieth century. Even scholars who did not see his scholarship as the final word on a subject nevertheless studied his work to create their own interpretations of the nature of society and the reciprocal relationships between science and society.

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SEE ALSO *Science, Technology, and Society Studies; Skepticism; Sociological Ethics.*

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META-ANALYSIS

Meta-analysis is the quantitative review of the results of a number of individual studies in order to integrate their findings. The term (from the Greek *meta* meaning after) refers to analysis of the conclusions of the original analyses. The methodology can in principle be applied to quantitative studies in any area of investigation, but it has become a basic tool in healthcare research. It is part of the broader approach of *research synthesis*, which also includes qualitative aspects.

Evolution of Meta-Analysis

Gaining an overview of the outcomes of different experiments is the constant aim of science, and statisticians have been concerned with the combination of results since the emergence of formal statistical inference in the early twentieth century. The basic principles were established by the 1950s (Cochran 1954), and the need became clear with the subsequent rapid increase in research publications. The procedure was first developed in the social sciences, and the term meta-analysis introduced in the educational literature in 1976. The 1980s saw mounting interest in the combination of results of clinical trials, and since the early 1990s meta-analysis has experienced explosive growth in medical applications.

Although there seems little doubt that meta-analysis is here to stay, it has been fraught with controversy. There is the problem of the *quality* of individual studies, with their own biases, often small clinical trials with poor design and execution. There is the problem of *heterogeneity,* studies that measured different effects, used different populations, had different aims. A further problem is that of *publication bias,* the fact that studies with positive results are more likely to get published than those with negative outcomes, leading to an inflation of the effect estimate. Related to this is *Tower of Babel bias,* meaning that most meta-analyses identify only reports published in English.

An international conference on meta-analysis was held in Germany in 1994, to review problems and progress (Spitzer 1995). A strong opponent present called the method "statistical alchemy for the 21st century" (Feinstein 1995). But work has continued, with the development of guidelines for doing meta-analyses, emphasizing the need to identify unpublished studies, eliminate incomplete reports and those of flawed research designs, and include only quality studies that appear to address the same well-defined question. The gold standard is that of *Individual Patient Data* (IPD), where the original data are available for reanalysis in the combined context. *Cumulative meta-analysis* is the systematic updating of the analysis as new results become available. There is also extensive research on meta-analysis for observational studies.

The Cochrane Collaboration

An important, promising development is the vigorous Cochrane Collaboration, "an international nonprofit and independent organization, dedicated to making up-to-date, accurate information about the effects of health care readily available worldwide. It produces and disseminates systematic reviews of health care interventions and promotes the search for evidence in the form of clinical trials and other studies of interventions" (Cochrane Collaboration). The movement was inspired by Archibald Cochrane (1909–1988), the British epidemiologist best known for his 1972 work *Effectiveness and Efficiency: Random Reflections on Health Services.* Cochrane urged equitable provision of those modes of healthcare that had been shown effective in properly designed studies, preferably randomized clinical trials. He considered the latter among the most ethical forms of treatment, and he emphasized the need for systematic critical summaries, with periodic update by specialty, of all relevant randomized clinical trials.

The first Cochrane Center opened in the United Kingdom in 1992, followed by the founding of the Cochrane Collaboration in 1993. In November 2004 its web site listed twelve Cochrane centers worldwide (using six languages) that serve as reference centers for 192 nations and coordinate the work of thousands of investigators. The main output of the Cochrane Collaboration is the *Cochrane Library* (CLIB), published and updated quarterly by Wiley InterScience and available by subscription via the Internet and on CD-ROM. Its contents include the Cochrane Database of Systematic Reviews (CDSRs), over 3,000 reviews prepared by fifty Collaborative Review Groups (CRGs), the Cochrane Central Register of Controlled Trials, bibliographic data on hundreds of thousands of controlled trials, as well as methodologic information on the rapidly developing field of research synthesis, and critical assessment of systematic reviews carried out by others.

The Ethics of Evidence

Meta-analysis, an attempt to integrate the information already on hand from past studies, enhanced by guidelines that it be done on the highest professional level, fits into the framework of the *Ethics of Evidence,* a multidisciplinary approach proposed for dealing with the uncertainties of medicine (Miké 1999). The Ethics of Evidence calls for the development, dissemination, and use of the best possible evidence for decisions in healthcare. As a complementary precept, it points to the need to accept that there will always be uncertainty.

To explore the quality of evidence from meta-analyses, a 1997 study compared the results of twelve large randomized clinical trials (RCTs) published in four leading medical journals with the conclusions of nineteen previously published meta-analyses addressing the same questions, for a total of forty primary and secondary outcomes (LeLorier et al. 1997). The agreement between the meta-analyses and the subsequent large RCTs was only somewhat better than chance. A third of the meta-analyses failed to correctly predict the outcome of the RCTs, and would have led to adoption of an ineffective treatment or the rejection of a useful one. (The actual differences between effect estimates were not large, but that did not count in this adopt/reject type of analysis.) Then in 2002 the long-held belief that menopausal hormone replacement therapy offered protection against heart disease, a medical consensus supported by meta-analyses, was shockingly reversed by RCT evidence (Wenger 2003).

The Cochrane Collaboration, as a worldwide, integrated movement, has the great potential to promote cooperation on high-quality, controlled clinical trials. Systematic reviews of these, with regular update and dissemination, should help improve the evidence available for the practice of medicine. But it is important to keep in mind that even the best meta-analysis cannot take the place of original research. *Evidence-based medicine*, which makes heavy use of the results of meta-analyses, cannot apply evidence that does not exist. Scientists need to stay close to the primary literature, with an open mind, to get new ideas, seek new insights, and generate new hypotheses.

The public needs to have a cautious view of meta-analysis, judging each case in its proper context. For example, the meta-analysis showing that more than 100,000 Americans die each year from the side effects of legally prescribed drugs (Lazarou et al. 1998) merits serious concern, even if the estimate is not quite accurate. There is no substitute for being informed, getting involved, and taking personal responsibility.

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SEE ALSO *Biostatistics; Statistics.*

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MILITARY ETHICS

Military ethics can mean a wide range of things. It can encompass all aspects of military conduct, from writing performance reviews on subordinates, to relations of military personnel with their civilian leaders, to issues related to war. For the purposes of this entry, however, the discussion will be limited to ethical questions concerning the use of military force for the redress of political disputes. As war becomes increasingly dominated by high technology weaponry (at least in the developed countries), there is an intimate link between developments in science and technology and the questions of appropriate military use of those advances as addressed by military ethics.

Fundamental Issues

Traditionally military ethics has emphasized an approach to just war thinking that has roots in classical and early-Christian sources. In post-Reformation and post-Enlightenment Europe, this ethical and religious tradition found secular and legal codification in the Laws of Armed Conflict (both in international law and in the specific military law of individual nations).

Traditional just war analysis attempts to specify the scope and limits of morally acceptable uses of military force. Two independent sets of judgments are involved. The first, *jus ad bellum* (justice/right *toward* war) considers whether the use of force under a given set of political circumstances is warranted at all. The second, *jus in bello* (justice/right *in* war) frames issues regarding the conduct of military forces in combat.

Jus ad bellum (whether to go to war) questions the extent to which the use of force is justified at all by posing a series of tests. These gauge whether there is a just cause for war, whether there exists a legitimate authority to authorize the use of force, whether there is proportionality in the damage likely to be caused by the use of force measured against the political stakes of the conflict, and whether possibly effective non-military means of resolving the conflict have been exhausted (*last resort*). There is also a *reasonable hope of success* criterion, intended to rule out pointless violence. Because, paraphrasing the great philosopher of war Carl von Clausewitz (1780–1831), war is *politics by another means,* it is important to see whether the desired political result is likely to be attainable. In addition, for a war to be justified, it must be waged for the sake of returning to a better state of peace and conducted with that intention.

It is important to note that although decisions about use of force at this level are clearly military ethics insofar as they are ethical decisions about the use of the military instrument of national power, they are not decisions that involve many military personnel. With the exception of the most senior military advisers to civilian authority, most individuals involved in this level of discussion are the civilian leadership of the nation.

The *jus in bello* (how to conduct war) considers whether care is being taken to be *discriminant* (i.e., to attack directly only military objects and to take precautions against destruction of civilian individuals or objects) and *proportional* (i.e., to expend only the amount of destructive force on a given target that is justified by its believed military importance). Unlike the global assessment of justification and proportionality made at the highest levels of government about whether or not to go to war, these decisions are made at all levels of combat, from the smallest tactical decisions of a rifle squad to the decisions of a theater commander regarding the structure and targets of a strategic bombing campaign.

While both the *jus ad bellum* and the *jus in bello* decisions belong to individual leaders in their official capacities at all levels, the broader society can and does also engage in ethical discourse about those decisions. Especially in a democratic society with abundant technologically mediated public sources of information, citizens as individuals, members of the press, opinion leaders, and so forth all make independent assessments of the ethical quality of the decisions of political and military leaders. Leaders must persuade their citizenry of the justifications for the use of military force in the world, and individual actions of the nation's military (sometimes down to the lowest tactical level) can and do become objects of national scrutiny and ethical assessment. The strength of the connection of the military to the democratic society it serves is decisively influenced by the degree to which the military and the society share a common moral frame of reference and a sufficiently robust common understanding of the realities of military affairs.

An emerging challenge in the area of military ethics and society is that, in large-scale democracies that eschew compulsory military service, fewer members of the society have any direct experience with the military—including pivotal opinion leaders and civilian political leaders. This creates the risk of a diminishing realistic sense of the scope and limits of the capabilities of military power in the society at large and a commensurate risk that the military will be challenged to explain its choices and actions to fellow citizens.

Military Ethics and Technology

Practical military ethics is intimately connected with the military technology available to combatants. Further changes in available technologies have profound ripple effects in the ethical assumptions and accepted ways of behaving of the military—often in ways wholly unanticipated when the technology was introduced and applied. In a phrase commonly attributed to Immanuel Kant, *Ought implies can,* meaning that it is pointless to say someone ought to do something unless the person is possessed of the capability to do it. But in areas of ethics and military technology, at least in some cases, capability calls for use or that *Can implies ought*. As technology makes it possible for military operations to be conducted in novel ways, especially insofar as these come closer to honoring the sprit and letter of the just war criteria, the requirement to do so becomes more stringent. Once acceptable weapons and tactics may, at least for militaries that possess new capabilities, be considered objectionable. With increasing precision in the targeting of air bombardment, it is difficult to imagine militaries possessed of that capability reverting to less precise weapons in any but the most dire of circumstances.

One important theme of the just war tradition is the attempt to make war as humane as possible, even for the combatants. This is manifest in the elaboration of the Geneva Convention rules requiring that combatants who surrender be entitled to *benevolent quarantine* by their captors, including medical care, adequate food and housing, and more. Underlying these rules is the sense that combatant is a temporary status overshadowing the more fundamental common humanity of adversaries. When combatant status is lifted, humanitarian concerns with the suffering and welfare of the individual reassert themselves.

Humanitarian concern, even toward combatants, in the tradition of military ethics is evidenced by periodic attempts to rule out whole classes of weapon technology as inherently inhumane. Such efforts began with medieval Christian church efforts to ban the crossbow as being too accurate and deadly over too long a range. Later the bans on asphyxiating gas weapons, blinding lasers, and hollow-point (so-called *dum-dum*) bullets, and attempts to ban nuclear weapons, all reflected an impulse to identify unethical classes of technology.

A review of these efforts, however, points up their largely ineffectual and erratic character. When each technology first emerged, it presented as a novel and horrific new weapon system. Some bans (most notably that on asphyxiating gas) have held as a matter of customary practice among civilized nations. But it is hard in almost every case to say precisely why certain weapons are uniquely horrific in comparison to other weapons systems developed and deployed later. The ban on gas, for example, may continue in part because of the depth of the historical memory of World War I and the unique horrors gas weapons caused in that conflict, but also because they are not especially effective weapons systems in comparison to alternatives developed later. It is hard to see, from any objective moral perspective, how being shot with a hollow point bullet (deemed inhumane because of the gratuitous destruction of tissue caused by the tumbling bullet in contrast with the *clean penetration* of a rigid bullet) is less humane than being bombed with a fuel-air explosive that generates tremendous heat and overpressures, and kills by blast and by sucking oxygen out of the environment.

The link between military ethics and technology is not primarily in connections between specific technologies and guiding ethical principles. Specific, technology-by-technology restraints will always be piecemeal, sporadic, and difficult to justify or explain on the basis of a uniform set of moral principles. The connection between military ethics and technology is more subtle and complex. The development of air power is perhaps the clearest example, and worthy of extensive specific review, of the general issues in raised in this regard.

Between the two world wars, a number of air power thinkers developed a theory about the best strategic use of the airplane and bombing. Italian Giulio Douhet and American Billy Mitchell both speculated that long-range bombing would obviate the need for a frontline and trench warfare, both of which were required in World War I. Instead, they argued, the bomber would fly deep into enemy territory and bomb factories, transportation, and other infrastructure essential to the adversary's war effort. They also proposed (without always noting that this was quite another matter) bombing civilians and whole cities directly in the effort to so demoralize the population that the will to continue the war effort would collapse.

The latter proposal ignores, at the most fundamental level, the principle of discrimination that is a cornerstone of the *jus in bello* element of just war thinking. Before World War II, world leaders publicly declared that indiscriminate attacks on cities were completely outside the realm of military ethics and never to be ordered. The U.S. policy of so-called *daylight, precision* bombing was an attempt to maintain the principle of discrimination. Given the technology available at the time and the inherent inaccuracy of bombing from high altitude, it was an effort that had little practical meaning. At the end of the war, all pretense of discrimination was abandoned as the Allied air campaigns culminated in the *conventional* firebombing of Dresden and the atomic bombing of Hiroshima and Nagasaki.

One might have thought that the principle of discrimination in military ethics had effectively been rendered obsolete by this pattern of practice, but it was not. Nuclear weapons, and other weapons of mass destruction of the biological or chemical type would, if used, be impossible to justify under any reasonable interpretation of the just conduct of war. But on the more conventional side of war, the principles reasserted themselves after the end of World War II. The Vietnam era (1964–1975) practice of *free fire zones* in which it was declared that, after notice, all in a given area would be deemed combatants was at least a verbal and legalistic effort to maintain the distinction. More importantly, the introduction late in the Vietnam era of television-guided precision munitions hinted at a whole new connection between technology and military ethics just over the horizon.

In the opening hours of the air campaign of the Persian Gulf War in 1991, the world was introduced to a new manifestation of the link between technology and military ethics. The generation of precision guided munitions (PGMs) that was used held the prospect (only partially fulfilled in that conflict) of *one bomb, one target* accuracy, in which strategic bombing might be conducted even in urban areas with collateral damage to civilians limited to weapons malfunctions and intelligence failures in designating targets incorrectly.

Technologies have only continued to improve. PGMs requiring the risky and difficult laser designation by a pilot during the Persian Gulf War had, by the Kosovo conflict in 1999, been replaced with Global Positioning System-guided weapons that were virtually infallible in finding their targets, without requiring pilot supervision. Targeting mistakes still occurred, of course. But these were largely failures of intelligence and programming rather than of inherently inaccurate or indiscriminate weapons. The Chinese embassy in Belgrade was bombed with great precision, in that the bomb's coordinates were hit precisely; the mistake was in programming those coordinates. Successful conduct of just war has always depended to a large degree on intelligence, of course, because correct identification of legitimate targets rests on intelligence in all but face-to-face encounters between adversaries. However, in combat driven by precision stand-off and robotic munitions of great accuracy, perhaps intelligence will bear the brunt of the moral responsibility for discrimination and proportionality.

Air power is an appropriate focus for a discussion of the connections between military ethics and technology because it is has undergone the most dramatic technological evolution in the post-World War II period. Technological developments for land forces are driven by similar technological and ethical imperatives, however, more in the quest for technologically produced total situational awareness of the battlefield and precisely targeted weapons. Naval forces, too, are increasingly platforms for launch stand-off precision weaponry. The historical review of more than fifty years of the development of air power is instructive in a number of ways, not just for its own sake, but also for what it illustrates regarding the connection between military ethics and technology. Most of that history focused on the ethical test of discrimination. If World War II degenerated into an indiscriminate air war, it was partly out of a misguided strategic idea that bombing civilians would be effective in hastening the termination of conflict and partly from inherent technological limitations of the weapons and platforms available. Subsequent technological development increasingly provided the capability to conduct effective strategic level air bombardment, but to do so in an increasingly discriminate way. So at first glance, here is a clear example of technological development dramatically assisting the abilities of military forces to operate within the boundaries of established principles of military ethics. Further, regarding that development only from the perspective of the ability of the U.S. Air Force and Navy to conduct discriminate strategic air campaigns, technology has provided the capability to meet the requirements of military ethical principles.

The existence of the various technologies of PGMs has, however, generated a number of unanticipated ethical issues as well. Especially stand-off weapons (that is, weapons that can be fired from long distance, placing the operator beyond the range of enemy counterfire such as Air and Sea Launched Cruise Missiles) have already dramatically altered some *jus ad bellum* calculations. The ethical requirement that use of military force be a last resort was always supported by the fact that the decision of a political leader to use force inevitably involved putting the military forces of that nation at risk and almost certainly suffering some casualties. But stand-off weapons hold out the tantalizing prospect of using military force with complete impunity—thereby dramatically lowering the threshold to the use of force. Last resort remains a moral requirement. But without risk to a nation's own forces, the prospect of using missiles *to send a message* might be a political leader's course of action when it would certainly not have been if the possible deaths of aircrews or special forces units had factored into the decision.

The capability that PGMs provide generates ethical issues in another area as well. Because only the United States and a few major high-technology powers possess these capabilities, the entire war convention is challenged when such powers engage in conflict with less technologically advanced states. The Law of Armed Conflict that codifies just war principles is intended to apply equally to and to be observed equally by all combatants. Yet this capability creates a situation in which the United States can scrupulously observe those laws and conduct a highly discriminate air campaign against a lesser adversary that, if it follows those rules, faces only certain defeat. Understandably adversaries equipped only with lower technology weapons come to feel that U.S. forces lack honor in conducting war in this way. To the degree that the respect for the criteria of just war rests on a mutual sense that war can be conducted within those limits and still be a *fair fight*, precision munitions built to honor the principles of discrimination and proportionality may come to undermine respect for those very rules on the part of adversaries.

In practical terms, this asymmetry of capability provides a strong incentive for any adversary to find asymmetrical approaches to offset U.S. capabilities, even if those approaches strain or violate established ethical principles of military conduct. The Iraqis and the Serbs (examples of such lesser powers under attack) have illustrated the consequences of this asymmetry in their use of human shields (their own citizens, captured civilians of the attacking and allied powers, or prisoners of war), deliberate collocation of military and civilian objects (fighter aircraft parked next to mosques, schools, and hospitals), and perhaps dual-use of factories for production of baby formula and chemical weapons (although these cases are less certain).

It is hard to say what exactly follows from these points regarding the status and future of military ethics. It is ironic that weapons developed precisely to return air power to scrupulous respect for the ethical principle of discrimination have the unforeseen and unintended consequence of contributing to undermining the shared respect for those very principles on the part of adversaries. What is clear is the difficulty of predicting nonlinear relationships between developments in military technology and the law and practices of military ethics.

The more general point about the relation of technology and military ethics concerns not a single technology and its implications, but rather the aggregate effect of the overwhelming technological superiority of the United States and, to a much lesser degree, its allies in the whole panoply of military technologies. Taken together, they provide the tools for those militaries to intervene effectively and widely against less technically advanced powers—at least powers whose militaries are conventionally structured. The example of Vietnam and other guerilla wars suggest that some kinds of asymmetry are relatively immune to high-technology capabilities developed to date, although there too, improved sensor and surveillance technologies offer advantages for land forces as well.

The *jus ad bellum* requirement of just cause has, during the twentieth century come to be restricted to defense against the aggression of others. However, since World War II, a body of human rights law (starting with the Genocide Convention) has begun to sketch out a parallel body of international law that gives less weight to national sovereignty and suggests that the rights of human individuals and groups might provide a basis for legitimate intervention if the state failed to properly protect those rights. Kosovo provided a possible model for the future when the technologically superior powers intervened with relative impunity to protect human rights.

But the existence of the capability also suggests a danger: The superior powers may no longer be constrained by the risks to their own forces and may use their unmatchable technologically-based military power in ways that destabilize rather than stabilize the international system. At its roots, the relatively stable system of mutually respected military ethics developed among the European powers worked, insofar as it did, because powers felt that respecting the rules of military ethics still made it possible to have a fair fight. This asymmetry of capability may make it possible for the technologically superior to operate *in bello* in ways that adhere to the rules of discrimination and proportionality, but within a wider frame *ad bellum* of excessive interventionism.

The Historical Development of Military Ethics

In almost every culture, the warrior class develops some internal sense of appropriate military behavior. While it would be wrong to suggest that the rules are equivalent, the need warriors have to distinguish honorable from dishonorable conduct in war seems nearly if not completely universal.

The specific version of military ethics that evolved into the ostensibly universal principles embodied in the Hague and Geneva Conventions has specific roots. These principles may be traced back to ancient Roman thought and practice, as mediated through history by the European Christian Church and its secularized successors.

Although elements from pre-Christian Roman thought and practice (e.g., Cicero), feed into the origins of just war, the Christian writer Augustine's work is the origin of the unbroken stream of Christian military ethics that leads to the elaborated tradition that exists in the twenty-first century. Augustine wrote during a period when the Roman Empire was collapsing under the weight of barbarian advance and, unlike most of his Christian predecessors, he advocated Christian participation in the military defense of the Empire. While it was far short of Christian religious and ethical ideas, Augustine argued, use of military force to defend the *tranquility of order* provided by the Empire was a legitimate act of Christian love. Military struggle and even death in defense of that order was an act of love for one's neighbors who, if that order were to fall, would endure great suffering.

The Christian soldier is governed by restraints in combat. It is the enemy's misconduct rather than the soldier's wish that brings about the war. The Christian soldier goes to war *mournfully*, accepting the blessing of Jesus as the peacemaker struggling to restore order on behalf of the neighbor. But most importantly, the soldier recognizes the common humanity of the adversary and avoids personal hatred or animus.

Augustine lays the foundation for a tradition that accepts the necessity of coercion and even violent conflict in the name of maintaining order. But it also imposes rules of restraint and caution that are elaborated in subsequent Christian tradition. In the medieval period, for example, Thomas Aquinas and other scholastics developed and elaborated the intellectual framework for military ethics, even as the Code of Chivalry formed the basis of ideal military ethics among the warrior class. During the same period, the idea of a Law of Peoples (*jus gentium*) evolved: a concept that became *customary international law* in later versions of the tradition.

Although the major actors of the Reformation produced their own versions of just war and military ethics in the sixteenth century, the collapse of the unified Christian civilization of Europe and the encounter of Europeans with the inhabitants of the New World spurred the need for a less *religious* and Eurocentric understanding of just war and military ethics. Catholic thinkers such as Francisco Suarez and Franciscus de Vitoria argued that the indigenous peoples of the New World possessed rights. Hugo Grotius, Samuel Pufendorff, and Emmerich de Vattel laid the foundations for a non-religious framework of military ethics and just war, grounded in human reason that would be valid (as Grotius put it) *even if God does not exist*.

The European Enlightenment of the eighteenth century completed the work of secularization. Rationalist thinkers such as Kant argued that ethics generally must be grounded in the nature of human reason alone and that reason dictated a more rational system than war for the adjudication of international disputes. He envisioned a League of Nations, willing and able to provide world governance on principles better reasoned than the perpetual conflict of interstate rivalry. Such ideas set in motion the hope of a united global community operating in accordance with shared ethical and political principles—an endeavor manifest in the creation of the League of Nations and the United Nations in the twentieth century.

Abraham Lincoln's charge to Francis Lieber to create General Order 100 marked a milestone in the establishment of a state-mandated set of rules for military conduct. Military Codes of Discipline came to replace customary Chivalric Codes as official guidance for governing the conduct of military personnel of the various nations.

At the end of the nineteenth century, under the auspices of the Hague and Geneva Conferences, treaty law governing the conduct of military operations and the treatment of civilians, the rights of neutral powers, prisoners of war, and so on, began to grow. This body of law is the partial codification of the long moral tradition of military ethics, and constitutes customary international law for all states and their militaries.

At the conclusion of World War II, war crimes trials, held in Nuremberg and Tokyo, established the precedent of individual responsibility of commanders and soldiers for war crimes. Although criticized by some as *victor's justice*, they laid the foundation for the idea of individual culpability for war crimes that has evolved into ad hoc war crimes tribunals for Rwanda and the former Yugoslavia. In 1998 the United Nations adopted the Rome Statute calling for the establishment of a permanent standing war crimes court. That treaty received a sufficient number of national ratifications and entered into effect on July 1, 2002; the process of appointing members and establishing procedures was ongoing in the beginning of 2004.

In the early 2000s, the United States was among a small number of states opposed to the creation of the war crimes court due to fears that it would be dominated by political considerations rather than disinterested justice, and by awareness that U.S. forces are more widely deployed (and therefore more likely to be subject to the court's scrutiny) than those of other powers. It is too early to say what the effect of the war crimes court will be. But in intention, it represents the culmination of efforts over many years to give legal shape, form, and enforcement to the fundamental principles of military ethics.

MARTIN L. COOK

SEE ALSO *Airplanes; Baruch Plan; Biological Weapons; Chemical Weapons; Geographic Information Systems; International Relations; Just War; Missile Defense Systems; Limited Nuclear Test Ban Treaty; Weapons of Mass Destruction.*

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MILITARY-INDUSTRIAL COMPLEX

The *military-industrial complex* is one of a series of ideas that aim to critique the manner in which science, technology, and society have interacted with one another since World War II. The term itself was popularized by U.S. president and World War II general Dwight D. Eisenhower (1890–1969) in a farewell address to the nation on January 17, 1961, in which he warned the American people against "the acquisition of unwarranted influence, whether sought or unsought by [such a] complex" and the corresponding threat it posed to democracy. Although defined as "the conjunction of an immense military establishment and a large arms industry," its influence extends beyond industry and the military (Eisenhower). Often called the *military-industrial-congressional complex*, for instance, it comprises the *iron triangle* of Congress, the Pentagon, and defense industries. Additionally because the military and industry both support and depend upon academic research, another iron triangle has been dubbed the *military-industrial-university complex* (Hughes 2004).

Context and Emergence

The precise origins of the term military-industrial complex are obscure, but the idea is not. During the war, the U.S. government became increasingly dependent on both industrial corporations and scientific research for the production and development of military weapons. Military needs far exceeded those of previous wars. A typical U.S. army division, for example, required 225 times the mechanical horsepower required in World War I (Abrahamson 1983). In response, industry and the scientific enterprise shifted focus to help with the war effort.

Ford Motor Company, for example, manufactured jeeps, general purpose vehicles, and B-24 Liberator aircraft at a rate of one airplane per hour at the peak of production (Grudens 1997). Boeing Aircraft Company designed and built both the B-17 Flying Fortress and the B-29 Superfortress bombers at a rate of up to 362 planes per month. In total, companies produced 303,717 planes during the war—including 18,481 B24s and 12,761 B17s—at a price of $45 billion. According to Henry Stimson, secretary of war under both presidents Franklin D. Roosevelt and Harry S. Truman, "if you are going to try to go to war, or to prepare for war, in a capitalist country, you have got to let business make money out of the process or business won't work" (Higgs 1995, p. 1).

At the same time, the National Defense Research Committee, later the Office of Scientific Research and Development (OSRD), secured vast new resources for scientific research aimed at solving wartime problems. As a result, two new efforts allowed for increased collaboration between large numbers of scientists toward set goals: the centralization and creation of national laboratories, such as Los Alamos and Oak Ridge, and the targeted funding of research projects at universities, such as the Massachusetts Institute of Technology (MIT) Radiation Laboratory and the University of Chicago reactor research.

With the war, funding for large-scale scientific research shifted from industry to government and thus enabled *big science* projects such as the Manhattan Project. The architect of this shift, OSRD chair Vannevar Bush, began a trend to fund and direct scientific research through the military that would last well beyond the end of World War II. New scientific and industrial relationships and institutions begun during the war soon became fixed in U.S. economic and political life with the immediate emergence of the Cold War (1945–1989). It was this entrenchment that Eisenhower sought to highlight as a danger to political life.

Post-Cold War Revival

Throughout the Cold War, increasing military budgets were justified by the Soviet threat. When the Soviet threat disappeared, so too did the justification for large military budgets. Yet neither large military budgets nor the power of the military-industrial complex diminished, they simply reorganized (Hartung). According to Columbia University professor Seymour Melman, the United States has a permanent war economy, having "been at war—somewhere—every year, in Korea, Nicaragua, Vietnam, the Balkans, Afghanistan" since the end of World War II (Melman).

As a result, both scientific and industrial enterprises remain directed toward military ends. The fiscal year 2005 research and development (R&D) budget includes $75 billion for defense R&D and $57.2 billion for nondefense R&D. Defense R&D, therefore, comprises 56.7 percent of the total R&D budget (AAAS 2004). Additionally the fiscal year 2005 defense R&D budget is nearly $20 billion above what it was at the height of the Cold War, adjusted for inflation but not for growth in the economy.

Defense contractors have gained considerable power and influence because of mergers between previously competing contractors. Because of their size and power, specific contractors—such as Lockheed Martin, Northrup Grumman, and Raytheon—can secure support through sizable congressional contributions. They do so by supporting those candidates with power over their pet programs. Of the forty top recipients of defense contractor campaign donations, thirty-six are on either the congressional Appropriations Committee (the committee with authority over government funds) or Armed Services Committee (the committee with authority over defense programs). As a result, weapons programs, such as the Lockheed Martin F-22 fighter, the most expensive bomber ever built, are not likely to be terminated.

When President George W. Bush was first elected, he and Secretary of Defense Donald Rumsfeld promised a revolution in military affairs in which they would create new, more agile forces. Bush suggested that they might "skip a generation of technology" in certain systems, which would require the elimination of at least one big-ticket system such as the F-22 fighter (Hartung 2001, p. 3). As a testament to the power of the defense industries, this has not happened and in fact "the Pentagon has not shut down a single major weapons production line since the end of the Cold War" (Hartung).

Ethics and Policy Issues

Several scholars have raised concerns about the military-industrial complex throughout the years, including that it is a threat to democracy and to the free market. Lewis Mumford argues that the military-industrial complex threatens democratic processes, because it has become a *megamachine*, a rigid, hierarchical social structure with absolute powers and little outside input (Mumford 1964). In effect, he argues against the authoritarian nature of the military-industrial complex. This echoes Eisenhower's warning that the American people must remain alert and knowledgeable to ensure that the complex "does not endanger our liberties or democratic processes" (Eisenhower).

Seymour Melman argues that the military-industrial complex endangers the free market, because it actually creates a state economy. He contends that appropriations for physical infrastructure, health, and welfare are drying up, and thus "the idea that the U.S. can afford guns and butter without limit is proven false every day" (Melman).

GENEVIEVE MARICLE

SEE ALSO *Military Ethics; Science, Technology, and Society Studies.*

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MILL, JOHN STUART

John Stuart Mill (1806–1873) was born in London on May 20. The son of the philosopher James Mill (1773–1836) and the godson of the philosopher Jeremy Bentham (1748–1832). John Stuart Mill was the most influential British philosopher of the nineteenth century, which saw science and technology transform society as significant contributions were made in metaphysics, logic, the philosophy of science, ethics, social and political philosophy, economics, the philosophy of religion, and the philosophy of education. The *System of Logic*

John Stuart Mill, 1806–1873. An English philosopher and economist, Mill was the most influential British thinker of the 19th century. He is known for his writings on logic and scientific methodology and his voluminous essays on social and political life. *(Hulton Archive/Getty Images)*

(1843) and the *Principles of Political Economy* (1848) became canonical textbooks in their fields. Mill died on May 8 in Avignon, France.

Logic

Mill understood his work in technical philosophy as providing a foundation for his social and political philosophy. The purpose of the discussion of the origins of knowledge in the *System of Logic* is to prepare the ground for the social sciences, and the discussion of the social sciences provides the grounds for Mill's moral, political, and economic views.

The first five books of the *Logic* are largely polemical, attacking the philosophical position known as intuitionism, which in the nineteenth century had served as the basis for political conservatism. Intuitionism takes the view that there are innate truths, including moral truths. Innate truths can be known independent of experience, and thus custom and tradition were elevated to the status of timeless truth impervious to empirical refutation. In contrast, Mill wanted to argue that customary practice is often no more than a historical accident or that although it may have been justified in earlier social circumstances, it had outlived its usefulness, and all practice should be subject to revision in light of changing circumstances.

Mill argued that almost every general principle in any domain was the result of an inductive process that began with individual experiences, although Mill conceded a few exceptions. For example, the general principle that nature is uniform seems to be an assumption that people bring to their experience insofar as there are many things people do not understand as examples of uniformity or for which they have no experience, although they continue to subscribe to this belief. There are diseases for which the cause or cure is not known, yet it is presumed despite the failure of past research that the hidden uniformity behind them will be discovered eventually. Mill insisted that these few exceptions had no moral or political implications.

Mill engaged in a protracted controversy with William Whewell (1794–1866), professor of moral philosophy at Cambridge, who had published a *History of the Inductive Sciences from the Earliest to the Present Time* (1837). Whewell coined the term *scientist* in recognition of the idea that traditional "natural philosophy" had become a new form of knowledge. Whewell was a critic of the philosopher Francis Bacon's (1561–1626) conception of the process of induction and wanted to redefine induction as the process by which scientific hypotheses are formulated. He considered this process a creative act rooted in history but not amenable to strict rules. In this he was close to the Kantian view that the most general principles of knowledge were not based on experience but instead were presuppositions. A successful hypothesis starts as a happy guess and evolves over time into a larger structure of thought incorporating both empirical and nonempirical elements. Whewell insisted on the historically evolving nature of scientific hypotheses and laws.

Mill objected on the grounds that Whewell was conflating induction with hypothesis formation and that what mattered was not the original happy guess but the subsequent inductive process by which the guess is confirmed by empirical observation. At this level Mill's dispute with Whewell was merely semantic.

Social Sciences and Technology

Mill contended that there can be a science of human nature and that its basic laws are the psychological laws of association. Moreover, the basic truths about human affairs, including questions of ends, are not part of the content of the psychological laws of association. To explain the basic truths of human action it is necessary to supplement the psychological laws of association with information about the circumstances in which those laws operate.

Human action, unlike physical interaction, cannot be explained in terms of current circumstances. Actions of human beings are not solely the result of their current circumstances but are the joint result of those circumstances and the characters of the individuals; the agencies that determine human character are numerous and diversified. Is it possible to give a systematic account of the circumstances, past as well as present? Mill at one time thought this possible. The science needed to discover and formulate the hypothetical laws of the formation of character he termed *ethology*.

Mill's views on technology are embedded in his historical account of the stages of economic growth. His view owes much to Scottish Enlightenment thinkers such as David Hume (1711–1776), Adam Smith (1723–1790), and Adam Ferguson (1723–1816). Economic and social progress is marked by three stages: savagery, barbarism, and civilization. By civilization Mill meant a modern industrial and commercial society with a liberal culture such as Great Britain. The rise and development of civilization are dependent on "the natural laws of the progress of wealth, upon the diffusion of reading, and the increase of the facilities of human intercourse" ("Civilization," *Collected Works*, Vol. XVIII, p. 127).

The third stage of *civilization*, as described in Mill's essay of that title, is marked economically by industry, politically by limited government and the rule of law, and socially by liberty. Mill saw examples of these combined features in military operations, commerce and manufacturing, and the rise of joint-stock companies. The consequences of the rise of civilization are economic, political, social, and moral. Economically, there has been a vast increase in wealth in which the masses and the middle class have been the primary beneficiaries. Politically, power is shifting from a few individuals to the masses.

Science, Technology, and Politics

Socially, the most important consequence has been the decline of individuality. The future of civilization depends on the masses exercising power in ways that allow the benefits of civilization to continue. Mill did not believe this would happen on its own. The masses must understand and appreciate the moral foundations of liberal culture.

Unlike both classical liberals such as the Philosophic Radicals Jeremy Bentham, James Mill, and orthodox Marxists, Mill was not an economic determinist. The moral world was not a product only of material forces. The functioning of the economy presupposed certain virtues. This explains Mill's economic position in the later *Principles of Political Economy*, the germ of the recommendations in *Representative Government* (1861), and the project that *On Liberty* (1859) would address. The social crisis created by the industrial revolution was class conflict. This crisis was exacerbated in Mill's thinking by the perceived coming of an increasingly democratic society.

Participation in a market economy informed by an individualist moral culture promotes different forms of virtuous behavior. Nevertheless, Mill insisted that there had to be a moral purpose to the technological project. The desire to employ the whole surface of the earth for the production of the greatest possible quantity of food and the materials of manufacture he considered to be founded on a mischievously narrow conception of the requirements of human nature. Among the many things Mill and his father had objected to most vehemently about the new industrial economy was the spoiling of the countryside by the many new and often duplicative railway lines. As hikers, they were sensitive to the destruction of natural beauty and the disappearance of solitude.

Mill also addressed the issue of the stationary state: an economy that no longer grows (a concern for classical economists but not neoclassical economists). Mill did not think that society had arrived at that state, and so more growth was probable. However, he did not consider a stationary state necessarily bad. Wealth is not an end in itself but a means to human fulfillment and individual liberty. Even if there were a stationary state of zero growth, freedom would not necessarily be lost.

Mill was the last major British philosopher to present an integrated view of philosophy and relate the theoretical and normative dimensions of his thought in a direct fashion. Book VI of the *Logic* remains the classic statement of what human science modeled after physical science might be, its limitations and qualifications, and the extent to which it may be useful. As a statement of the aims of and obstacles to the creation of the human sciences, it is unsurpassed.

NICHOLAS CAPALDI

SEE ALSO *Consequentialism; Liberalism; Locke, John; Scientific Ethics.*

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MINING

From the moment humans discovered stone tools and salt, they have been extracting and using materials from the Earth. Every American will utilize approximately 2.4 million pounds of mined materials during their lifetime (calculated from Mineral Information Institute statistics). In spite of people's dependence on the products of extractive technologies and their associated sciences, mining is a highly controversial activity surrounded by ethical, political, social, and legal issues. Mining focuses attention on the metaphysical relationship of humans to the Earth, on the impact of their activities on the environment and other species, on issues of equity and sustainability, on human rights and democracy.

Mining is the extraction of metallic or nonmetallic materials from the Earth. The full cycle of mining involves exploration for the material required; mining *sensu stricto*, which is the physical removal of material from the Earth; processing, which is usually required to concentrate or clean the ore; the health, safety, and environmental issues associated with the full cycle of mining activities; and appropriate closure of the site when mining is completed (National Research Council 2002).

Surface mining, where material is separated directly from the surface of the Earth, is the oldest and most common method of mining. Underground mining, where the material is extracted via tunnels dug into the Earth, is used to work deeply buried ores. Mining technology has evolved greatly, but the basic concept of removing rock or minerals from the Earth has remained constant since prehistory. Nonentry mining, by which the valuable components of the rock are extracted without physically removing the surrounding rock, is still at an experimental stage.

The many ethical, social, and political challenges associated with mining can only be addressed within the context of the prevailing philosophical view of the relationship of human beings to the Earth and its resources. From prehistoric time through the sixteenth century, many cultures regarded Earth as animate. Ores grew and matured in the uterus of the Earth; mining was an interference with the natural order and was often accompanied by myths and rituals (Eliade 1962). In the Western world, the organic view of nature was superceded by a mechanical model during the Scientific Revolution: The Earth is inanimate, and its resources should be exploited for the benefit of humans (Merchant 1980). In the late twentieth century, scientists developed holistic syntheses that integrate humans, other living beings, and Earth in an all-encompassing, interdependent Earth system. Some philosophers emphasize the importance of the humanities in understanding the full dimensions of the human–Earth system relationship (Frodeman 2003). These cross-disciplinary concepts are the basis for most modern interpretations of the place and responsibilities of mining.

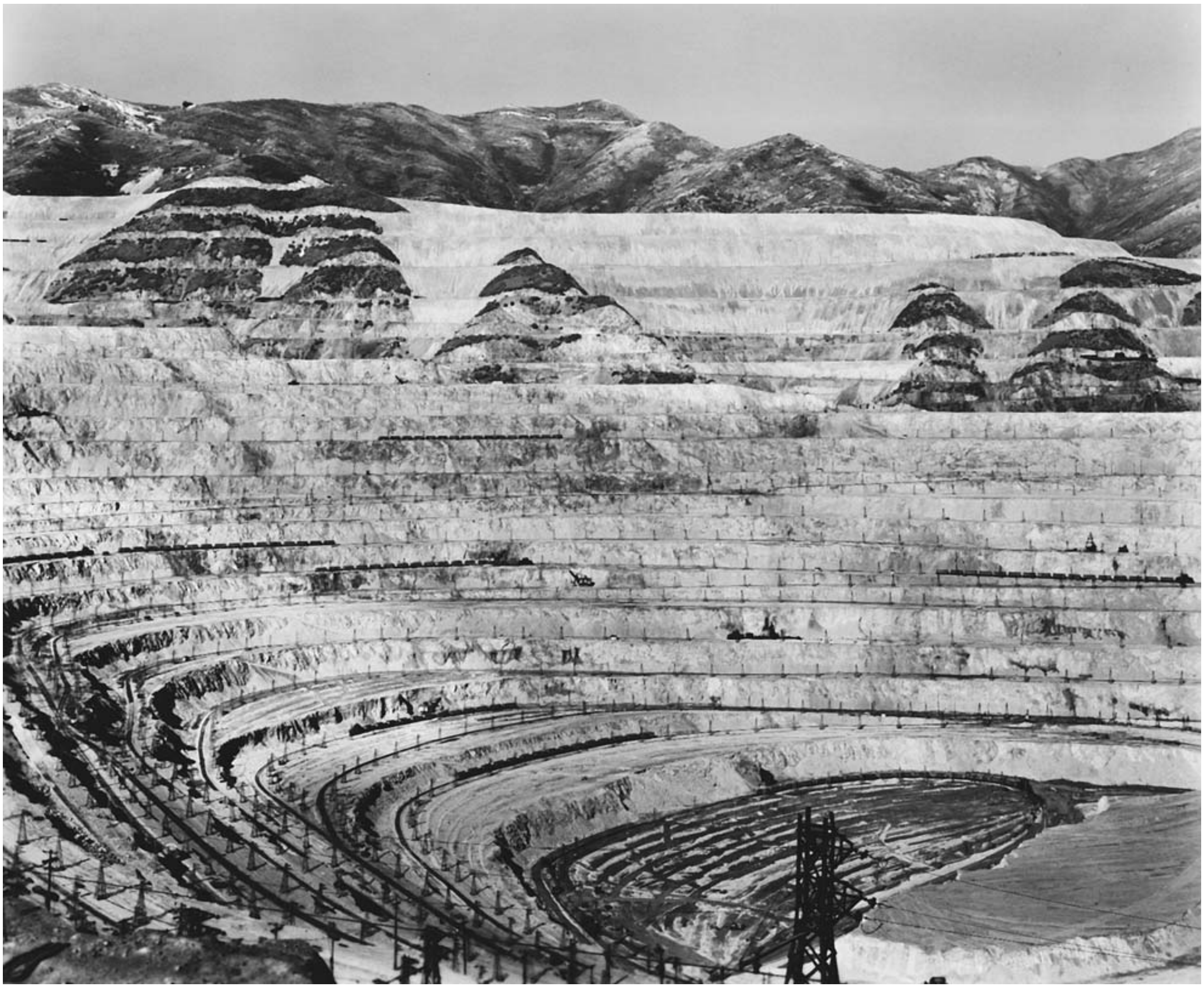
Polarized positions on the ethics of mining are strongly developed and there have been few true dialogs on the subject. One early-twenty-first century attempt to foster communication is the Mining, Minerals, and Sustainable Development Project, which concluded that economic, social, environmental, and governance issues must be addressed appropriately by all participants in order to meet the conflicting demands of society for the products of mining while still maintaining sustainability (International Institute for Environment and Development, and World Business Council for Sustainable Development 2002). Finding mechanisms whereby all the stakeholders can be involved in negotiating acceptable practices and compensation for mining has proved difficult. Some nongovernmental organizations and companies have promoted formal or informal democratic fora, but they have been difficult to implement in areas lacking good governance or a history of citizen participation.

Mining is inherently inequitable. Earth resources are not distributed evenly, and mines can only be located where there are suitable resources. Many of the social and environmental consequences of mining are concentrated at the mine site even if the consumer or ultimate beneficiary of the mine product, or the wealth it creates, is far away. Resolving these inequities are

Underground mining as depicted in Georgius Agricola's *De Re Metallica* (1556). *(© Bettmann/Corbis.)*

some of the major ethical and political challenges associated with mining.

A fundamental question concerns ownership and control of the mineral endowment. Does a nation, or a sovereign, or a dictator, own the mineral wealth of a country? Or is it instead the landowner, the owner of the mineral rights, the person or company who discovered the deposit, the artisan miners who may have worked the deposit, or the local community (however defined)? In many cases the owner of a mineral deposit is not competent to mine it. In capitalist societies the high financial risk of mineral exploration and mining is usually borne by corporations that also supply technical expertise, and in return expect a profit from their investment. Almost every country has devised a different formula for regulating mineral ownership and control, for calculating taxes, and for oversight of mining activities and their impact.



The Bingham Canyon copper mine in Tooele, Utah. This mine is the world's largest man-made excavation. Kennecott Utah Copper Corp. produces copper, molybdenum, gold, silver, platinum, and palladium from the century-old mine. *(© Bettmann/Corbis.)*

A mine may introduce large amounts of capital or people into an area, distorting the economic and social structure. Corruption may become a problem. Wars are fought over the control of resources, and illicit trade particularly in diamonds and columbite-tantalite has funded conflicts, such as those in Angola and Congo, in the twentieth and early-twenty-first centuries. Safeguarding the human rights of workers and local populations is also a concern. Disciplined and transparent governance by governments and companies is necessary to stabilize the impact of mining.

Economic analysis shows that the Earth is unlikely to run out of mineral resources in the twenty-first or twenty-second centuries, which is as far forward as such predictions can be made, but the total cost of mining (including environmental, social, and other external costs) may limit the willingness to produce minerals (Tilton 2003). The role of mining in sustainable development is controversial, and conclusions largely depend on what values or assets one wishes to sustain, and on the scale at which the question is examined. Tilton (2003) argues that mining can contribute to global sustainable development if the products and profits of present-day mining are used to provide other assets of equivalent or greater value to succeeding generations. Analyses that concentrate on preserving the lifestyle, economy, or environment of a particular location are more likely to conclude that mining is a temporary phenomenon which disrupts rather than sustains development.

Technological innovation may lessen the demand for mineral products and lower the environmental impact of mining, but intellectual innovation is also vital to resolve the social and cultural consequences of mining.

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SEE ALSO *Acid Mine Drainage; Development Ethics; Environmental Ethics; Sustainability and Sustainable Development.*

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MISCONDUCT IN SCIENCE

Overview
Biomedical Science Cases
Physical Science Cases
Social Science Cases

OVERVIEW

In the United States the official definition of research misconduct is:

> ... fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.... Fabrication is making up of data or results and recording or reporting them. Falsification is manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.... Plagiarism is the appropriating of another person's ideas, processes, results, or words without giving appropriate credit. Research misconduct does not include honest error or differences of opinion. A finding of research misconduct requires that: There be a significant departure from accepted practices of the relevant research community; and the misconduct be committed intentionally, or knowingly, or recklessly; and the allegation be proven by a preponderance of the evidence. (Office of Science and Technology Policy 2000, p. 76262)

A somewhat broader definition of scientific misconduct has been put forward by the Wellcome Trust, the largest biomedical charity in the United Kingdom:

> ... [t]he fabrication, falsification, plagiarism or deception in proposing, carrying out or reporting results of research or deliberate, dangerous or negligent deviations from accepted practices in carrying out research. It includes failure to follow established protocols if this failure results in unreasonable risk or harm to humans, other vertebrates or the environment. (Koenig 2001, p. 1411)

Germany (Bostanci 2002) and China (Yimin 2002) have also developed definitions of scientific misconduct that are somewhat broader than the U.S. version.

In all cases, core elements of the definition of misconduct in science (also known as scientific or research misconduct) include fabrication and falsification of research data, and plagiarism (FFP). This reflects both philosophy and history. Researchers depend on the reliability of the published work of others in order to determine how best to design and conduct investigations of research questions. Rather than reproducing all related experiments, investigators expect to be able to build on previous research, not only their own but also that of others. Thus fabrication and falsification undermine the fundamental and central tenets of the scientific enterprise. In addition, researchers expect to be recognized and held accountable for their contribution to a scientific body of knowledge. Plagiarism violates this expectation.

History

Although in retrospect the work of some earlier scientists has been the subject of debate (Broad and Wade

1982), during the seventeeth, eighteenth, and nineteenth centuries the only significant discussion of misconduct among scientists was an isolated work by Charles Babbage (1830), which identified three types of misconduct: *trimming* data to fit expectations; *cooking* data by discarding what did not fit expectation; and the outright forgery or creation of fictitious data. The most famous instance of scientific forgery occurred in the early-twentieth century with the *discovery* of Piltdown Man.

In the 1980s, blatant examples of research misconduct came to light (Broad and Wade 1982, Sprague 1993). As a result congressional committees responsible for oversight of various aspects of science and technology pressured funding agencies to develop policies to address what seemed to be the increasing incidence of scientific misconduct. These agencies, in particular the National Institutes of Health (NIH) and the National Science Foundation (NSF), developed policies designed to explicitly identify and address allegations of scientific misconduct.

In its initial policy, the NIH described misconduct as "serious deviation, such as fabrication, falsification, or plagiarism, from accepted practices in carrying out research or in reporting the results of research" (Public Health Service 1986, p. 2), a definition from which later definitions have derived (Buzzelli 1999). Fabrication, falsification, and plagiarism are clearly provided as examples and the *other serious deviation from accepted practices* (OSD) clause emphasizes the primary role of the scientific community in identifying and setting the ethical standards for its members (Buzzelli 1999). Thus the OSD clause reflects the widespread view that the scientific community has a collective responsibility for establishing and upholding the professional standards of the community (Chubin 1985, Frankel 1993). The OSD clause is a common element of definitions of scientific misconduct found in many policies developed by U.S. funding agencies, universities, and professional societies. Nevertheless, in defining scientific and research misconduct, in the United States, the scientific community has tended to focus on FFP and has opposed the OSD clause (National Academy of Science 1992, Buzzelli 1999).

In 1993 the Commission on Research Integrity (CORI) was formed to advise the U.S. Department of Health and Human Services (DHHS) on ways to improve the Public Health Service response to allegations of misconduct in biomedical and behavioral research. The Commission found that in spite of the community's seeming preference "for a narrow and precise definition centered upon 'fabrication, falsification and plagiarism (FFP)' 'FFP' is neither narrow nor precise" (CORI 1995, p. 8). CORI's report, "Integrity and Misconduct in Research" (1995) clarified the role of intent in research misconduct and reframed the definition in terms of *misappropriation* of words or ideas (specifically including information gained through confidential review of manuscripts or grant applications), *interference* in the research activities of others (i.e., intentionally taking, hiding, or damaging research-related equipment, materials such as reagents, software, writings, or research products), and *misrepresentation* of information so as to deceive, either intentionally or with reckless disregard for the truth (thereby covering both fabrication and falsification). They also identified as other relevant forms of professional misconduct obstruction of investigations of research misconduct and noncompliance with research regulations, and highlighted the need to protect from retaliation those who bring forward good faith allegations of misconduct (commonly known as whistle-blowers). In addition, the Commission emphasized the need for a proactive rather than reactive approach to misconduct in science and recommended that research institutions be required to provide education in research integrity.

Assessment

In the 1980s when concerns about the frequency of scientific misconduct were initially raised, the common response by senior members of the scientific community was that scientific misconduct is rare and in any case science is self-correcting. Given that FFP not only undermines but is inconsistent with the bedrock principles on which scientific research is based, it is not surprising that members of the scientific community would assume that genuine, authentic, and bona fide members of the community would not engage in such practices and that their occurrence would be rare. Indeed the frequency of misconduct continues to be debated. At the same time, it has become clear that the peer review process is largely incapable of detecting fabrication or falsification. What is not in doubt is the serious negative impact of even a single occurrence of misconduct not only for those involved and for those whose work is misdirected by fraudulent research, but also the negative impact on trust both within the scientific community and beyond (Kennedy 2000).

An apparent tension continues with regard to internal (i.e., within the scientific community) versus external governmental control of both the definition of scientific misconduct and of oversight of scientific research. However the tension may be more apparent than real since the scientific community is not homogeneous with regard to its views on research integrity and