# Technology, philosophy of

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The philosophy of technology deals with the nature of technology and its effects on human life and society. The increasing influence of modern technology on human existence has triggered a growing interest in a philosophical analysis of technology. Nevertheless, the philosophy of technology as a coherent field of research does not yet exist. The subject covers studies from almost every branch of thinking in philosophy and deals with a great variety of topics because of a lack of consensus about the primary meaning of the term 'technology', which may, among others, refer to a collection of artifacts, a form of human action, a form of knowledge or a social process.

Among the most fundamental issues are two demarcation problems directly related to the definition of technology. The first concerns the distinction between technological (artificial) and natural objects. It involves the relation between man, nature and culture. The second pertains to the distinction between science and technology as types of knowledge. The science–technology relationship has become of central importance because of the widespread assumption that the distinguishing feature of modern technology, as compared to traditional forms of technology, is that it is science-based. Another much discussed issue is the autonomy of technology. It deals with the question of whether technology follows its own inevitable course of development, irrespective of its social, political, economic and cultural context.

## 1 Philosophy and technology

The following enumeration of approaches is intended to convey an impression of the strongly fragmented field of study that goes by the name of philosophy of technology.

What is (the essence of) technology? In philosophical-anthropological studies, the starting point for answering this question is the human being and its place in and relation to nature. The human being is considered to be a defective animal that is dependent on technology for its survival; technology becomes the substitute for biological shortcomings and is therefore determined to a large degree by the nature of these shortcomings. For Heidegger (1977) such a characterization of the essence of technology is not sufficient; an answer at the metaphysical level is also needed. For him the essence of technology is not that it is a means to some end: technology brings to the fore what was hidden and does not by itself present itself (see Heidegger, M. §6; Heideggerian philosophy of science). In Dessauer's (1927) metaphysical approach, invention is the essence of technology and the ontological conditions that make invention possible are explored.

The social philosophy of technology focuses on the relations between (specific forms of) technology and social, economic and political structures. It analyses technological development as a social process and addresses the problem of how to control its development. One of the key problems in this field is whether technological development is primarily determined by its context (social shaping of technology), or whether technology determines the social context including its systems of norms and values (a position often attributed to Marx). In the latter case, the idea of a technocratic society emerges in which technological rationality imposes itself on all domains of social life (technology as an ideology (Habermas 1968); see Habermas, J. §1).

Ethical studies take a prominent place in the philosophy of technology. New technological possibilities for human intervention create new moral problems. Do these require new ethical principles? Arguments in favour are based mostly on the idea that modern, science-based technology is essentially different from earlier forms of technology (the crafts), and that its impact on man and nature is of a different order (for example, the consequences of applying modern technology are no longer limited in space and time (Jonas 1984)). Another issue in this field concerns the claim that technology itself, as a system of means, is ethically neutral. Arguments against the neutrality thesis attempt to show that the conception of technology as a mere system of means is inadequate, because its impact on human life stretches much further: it replaces the natural with an artificial environment (see Technology and ethics).

The so-called 'analytical philosophy of technology' (Rapp 1974) shows a strong focus on epistemological and methodological problems of technology, particularly of the engineering sciences. These problems have long been neglected, because of the widespread idea that technology is applied science. A specific feature of this approach is that it takes into account the various types and stages of technology and its concrete historical form of appearance. Key topics are the nature of technological knowledge, the nature of engineering design, design methodology and the relation between science and technology. Its main disciplinary sources are, besides philosophy, technology itself and the history of technology.

## 2 Technology and artifacts

The usual conception of technology is that it is the transformation or manipulation of nature (the existing physical (material) and biological environments) to satisfy human needs and goals. Technology is thus conceived to be a specific form of purposeful (teleological) action, that may result in a 'technological artefact': a human-made object or state of affairs that fulfils a utilitarian or practical function. The transformation of nature may or may not itself be mediated by artifacts, which are then called tools (see Teleology).

This conception of technology raises many questions. On the one hand, it appears too restrictive, for it does not fit certain domains which are considered to belong to modern technology, such as software engineering which deals with the transformation of something immaterial (information). On the other hand, it is too broad, since it makes any object or state of affairs which satisfies a practical need, and is the result of intentional human intervention in nature, a technological artefact (for example, a wild tree planted deliberately at a certain place to provide shadow, or an organism with a slightly modified genetic structure).

The demarcation problem – what kind of action constitutes a technological action and what kind of objects or states of affairs are technological artifacts? – remains an open issue. Not only is the distinction between the technological and the artificial problematic, but also that between the artificial and the natural. The latter raises fundamental philosophical issues about the relation between the human race and nature. The distinction makes sense only if the human race is considered in some respect not to be part of nature. As an integral part of nature (and as a result of natural evolution), a human being cannot interfere with nature. The distinction between the natural and the artificial is commonly taken to be identical to the distinction between the spontaneous and the intentional; these notions themselves, however, raise all kinds of philosophical problems (see Environmental ethics §4).

Similar questions arise when technological artifacts are characterized as objects that perform practical functions on the basis of *human designs*. In technology a design is taken to be a pattern or scheme that describes the structure and mode of operation of a system and shows how a given practical aim or function may be realized. The notion of design stresses the inherently intentional/teleological nature of technological artifacts. The distinctive feature of technological artifacts as compared to objects from nature remains problematic, however. Is the difference primarily a genetic one (produced by humans or by nature), or is it more fundamental in the sense that the attribution of a design to objects of nature is meaningless (as in the modern scientific conception of nature)? These questions inevitably lead to issues in the philosophy of nature.

## 3 Technology as knowledge

For Aristotle science and technology belonged to two different spheres of human experience (contemplation versus productive action) and constituted two different forms of knowledge (theoretical versus practical knowledge). Scientific knowledge was, moreover, not inherently relevant for solving technological problems (see Aristotle §6). Modern technology and science, however, have merged to such a degree that even the demarcation between them has become problematic. Modern technology is science-based (and modern science, technology-based) and alongside the traditional natural sciences engineering sciences have established themselves. The so-called ‘scientification of technology’ is generally considered to be the characteristic feature of modern technology that is directly related to its prominent role in society. This has directed attention to the problem of the relation between science and technology and how science has altered the nature of technology. From a cognitive point of view, the nature of technological knowledge and its relation to scientific knowledge is at issue.

One of the most influential models for the science–technology relationship has been the technology-is-applied-science model. It stresses that technology, in contrast to the traditional crafts, is as theory-laden as science and that it applies scientific theories to systems which are of practical use. It considers technological knowledge to be a derivative kind of scientific knowledge. This model has been criticized severely. It is historically inadequate because it makes technological progress wholly dependent on scientific development. From a cognitive point of view it is highly problematic because it assumes that there is a logically deductive path from scientific knowledge (theories) to technological designs.

A generally accepted alternative for the technology-is-applied-science model is, however, still missing. A strong case could be made for considering technological knowledge, with respect to scientific knowledge, to be a form of knowledge *sui generis*, which deals with the design and production of artifacts. One of the considerations in favour of such a view concerns the fact that the criteria for evaluating cognitive claims are fundamentally different in the two domains.

In its most basic form technological knowledge is prescriptive; it consists of procedures (rules) which describe actions that have to be performed in order to achieve practical ends. Often, an adequate performance of these actions requires practical skills; these also constitute a form of technological knowledge, which, however, cannot be expressed in terms of prescriptions in language. The first criterion for evaluating a procedure that purports to solve a technological problem is its *effectiveness*: does the procedure bring about the desired state of affairs? The second criterion for assessing a solution is its degree of *efficiency*: is it possible to bring about the desired state of affairs in a better way, that is, with less effort or costs. (In general, measures of efficiency are based on quantitative comparisons of input and output of technological systems.) In modern technology, the notion of efficiency plays a dominant role, and the evaluation of the efficiency of artifacts is often carried out with theoretical means; at this point scientific theories about the operative principles of an artefact turn out to be of great value.

While efficiency, effectiveness, and other criteria like durability, costs, manufacturability, safety and utility, are key notions in the structure of thinking in technology, they play almost no role in science, because scientific knowledge is primarily descriptive and explanatory. Among its principal evaluative criteria we find truth, empirical adequacy and explanatory power. This difference in basic concepts for interpreting and evaluating knowledge claims strongly supports the idea that two different forms of knowledge (and of rationality) are involved in science and technology. Further insight into the characteristic features of technological knowledge, that is, in the epistemology of technology, has to come from detailed case studies (Vincenti 1990).

## 4 The dynamics of technological change

A recurrent theme in the philosophy of technology is the autonomy of technological development relative to its social embedding. It concerns the dynamics of technological change. This is an extremely complex topic since technological innovation, in its various stages from design, development, production and diffusion, is influenced by very heterogeneous factors (cognitive, economic, social, political, military, geographic, cultural, and so on). Views on the dynamics of technological change tend to show strong reductionistic tenets by taking one of these factors as the prime mover of technological change. Well-known illustrations are ‘technological determinism’ and ‘social constructivist interpretations of technology’. According to technological determinism technology itself is the prime mover; this view maintains that technology follows its own intrinsic course of evolution to which society has to adapt; it is self-determinative with increase of efficiency as one of its main dynamical principles. So there is no room for alternative forms of technology. Social constructivist interpretations of technology, on the other hand, claim that technology is to a large degree, or even completely, socially determined (see Constructivism).

In order to uncover some of the basic assumptions underlying these ideas we will briefly examine the shaping of artifacts in the design phase. The final form of an artifact is schematically determined by two kinds of constraint. On the one hand, there is the list of specifications which describes all kinds of requirements the artefact should fulfil. This heterogeneous list may contain, among others, constraints derived from the primary technological function of the artefact, the conditions under which this function has to be performed in practice (for instance, safety regulations), the conditions under which the artifact has to be produced (for example, mass production), its price, standards and norms. The defining feature of this list is that it is the outcome of a process of negotiation between all parties with some interest in the artefact; it contains social or contextual constraints, which are imposed by convention. On the other hand, there is a list of technological constraints, constraints due to what is, as a matter of fact, physically and technically possible (this list may, of course, change over time). The desired artefact should satisfy both lists of constraints, but because of conflicts this is often not possible in practice. Such conflicts can be resolved, again schematically, by adapting the list of specifications or by creating new technological possibilities.

According to this conception of the design process, the driving force behind technological change is the tension between two lists of constraints which are different in nature (one describing what is desirable, the other what is possible) and in principle independent of each other. Defenders of the autonomy of technology reject this independence; they assume that the list of specifications is determined primarily by technological constraints (‘what can be done, will be done’). The decisions leading up to the list of specifications are supposed to be dictated by technological imperatives (technological rationality). Social constructivists, on their part, tend to deny any difference in nature between the two types of constraint: they assume that physical and technological constraints are socially constructed in ways similar to the constraints contained in the list of specifications.

These assumptions may be criticized on philosophical grounds, but much more important for the assessment of these views is that the issue of the autonomy of technology is not to be settled by philosophical arguments alone. Models for the dynamics of technological change (with their underlying philosophical assumptions) must prove their value in empirical research, particularly in the history of technology. Generally speaking, a ‘historical-empirical turn’ in the philosophy of technology might prove to be fruitful for developing more adequate conceptual schemes for interpreting technology and its development.

## Technology and ethics

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Only within the modern period have philosophers made a direct and sustained study of ethics and technology. Their work follows two philosophical traditions, each marked by distinct styles: the Continental or phenomenological tradition, and the Anglo-American or analytical tradition.

Hans Jonas (1979) articulated one of the basic premises of Continental approaches when he argued for technology as a special subject of ethics: because technology has fundamentally transformed the human condition, generating problems of global magnitude extending into the indefinite future, it calls for a new approach to ethics. Jonas' basic premise is expressed variously in the works of Karl Marx, Max Scheler, José Ortega y Gasset, Martin Heidegger and others.

Work within the Anglo-American tradition tends not to deal with technology as a whole but to be organized around particular technologies, such as computing, engineering, and medical and biological sciences. It draws on concepts and principles of traditional ethical theory at least as a starting point for analyses. Although each of the technologies has a unique set of problems, certain themes, such as responsibility, risk, equity and autonomy, are common to almost all.

Social scientists have also raised important issues for the field of ethics and technology. Their work has yielded two dominant schools of thought: technological determinism and social constructivism.

## 1 Attitudes to technology

The history of philosophy contains two broad moral appraisals of technology. The first, implicitly present in most normative theories prior to the Renaissance, is that technological change is socially destabilizing and therefore should be delimited carefully. Without social stability, it was argued, people die even under conditions where nature is abundant, and technological change easily undermines such stability. The second, characteristic of modern ethics, is that technological change is inherently beneficial because it enhances human welfare and autonomy. Here the argument is that people suffer more from the elements than from other human beings, and that they should therefore work together to conquer nature through technological progress. These two broad ethical views further reflect opposed ideals of human life: on the one hand, an ideal of social community subordinate to nature; on the other, human autonomy and freedom from natural constraint (see Technology, philosophy of).

Only within the modern period have questions of ethics and technology been examined in detail, with two approaches emerging. One grows out of the Continental or phenomenological tradition in philosophy, the other out of the Anglo-American analytical tradition (see Analytical philosophy; Phenomenological movement). Continental philosophers seek to evaluate technology as a whole while Anglo-American philosophers are oriented towards piecemeal assessments of particular technologies. Continental philosophers also commonly argue that traditional ethical theories are inadequate to the moral issues presented by modern technology, whereas Anglo-American philosophers have been more comfortable adapting existing utilitarian or deontological ethical frameworks (see Deontological ethics; Utilitarianism).

## 2 Continental discussions

Within Continental discussions, Hans Jonas has made the most sustained argument for technology as a special subject of ethics. For Jonas, ethics in premodern times could reasonably allow technology to remain in the background because technology itself had no high moral purpose. Unlike politics or religion, for instance, technology was treated as a marginal aspect of human life, one limited in both power and effect. By contrast, during the modern period technology entered the foreground of human experience. According to Francis Bacon (1620), for instance, the inventions of printing, gunpowder and the compass have done more to benefit humanity than all politics and religion. Jonas believes that because of the Baconian evaluation of technology, 'modern technology has introduced actions of such novel scale, objects, and consequences that the framework of former ethics can no longer contain them' ([1979] 1984: 6). According to Jonas, 'no previous ethics had to consider the global condition of human life and the far-off future, even existence of the race. These now being an issue demands… a new conception of duties and rights, for which previous ethics… provided not even the principles' ([1979] 1984: 8).

The exact way in which technology engenders an epochal transformation of the human condition is, however, open to dispute within Continental discussions. Philosophers as diverse as Karl Marx, Max Scheler, José Ortega y Gasset, and Martin Heidegger all claim that modern technology has transformed the human condition and undermined traditional moralities. But about the particular ways in which technology has altered the human lifeworld there are major disagreements. With regard to appropriate moral responses there are still further disputes.

According to Marx (1867), for instance, 'the modern science of technology' undermines traditional skills and the satisfactions of craft production, placing workers under the control of large-scale, capitalist-owned factories in which labour functions have become equal and interchangeable. The new system of production destroys a traditional social ecology in which the 'species essence' of making things benefited all social classes. Under capitalism material production unequally benefits the upper classes. This disequilibrium can be corrected only by means of a social revolution in ownership of the new technologies. The Marxist ethical assessment of industrial technology thus points up the inadequacy of the modern economic order as a means for the social control of technology, because of the way participation in that order has been restructured by technological change (see Marx, K. §4).

According to Scheler (1915), the technological transformation of the lifeworld is more than an economic phenomenon; it is also the rise and dominance of a new 'ethos of industrialism' even among technical workers themselves. Such an ethos exalts utility and instrumental values such as efficiency over vital and organic ones such as love. This is an axiological disorder that calls for cultural reformation.

For Ortega (1939), however, inherent within the modern science of technology and the ethos of industrialization there arises a moral problem that cannot be addressed by means of either Marx's social revolution or Scheler's cultural reform. Modern scientific technology, in contrast with traditional crafts, radically increases what can be done without any corresponding enhancement of ideals about what should be done. In Ortega's own formulation of the issue: in the pre-modern period, human beings acquired only very specific technical abilities, tightly coupled to particular uses, such as pottery for making pots. They never possessed any generalized technological powers. Now, however, human beings do possess technology in general without any clear idea of particular uses. To address this problem Ortega suggested a need to cultivate what he called 'techniques of the soul' such as yoga.

Undoubtedly the most influential European philosopher to address the issue of ethics and technology, even though he explicitly rejects the discipline of ethics as such, is Heidegger. Heidegger undercuts the distinction between science and technology, and argues that modern scientific technology or technoscience is not so much an ethos as a form of truth. This truth or knowledge reduces the world to *Bestand* or resources available for manipulation by a world-configuring, nihilistic destiny he calls *Gestell*. Heidegger seems at once to make ethical reflection more necessary than ever before and to destroy its very possibility (see Heidegger, M. §6).

One of Heidegger's less controversial theses is the notion that science and technology are interpenetrating practices: the science of nuclear physics is as much the applied technology of cyclotrons and reactors as the technology of nuclear engineering is applied nuclear physics. To the extent that this is the case, the ethics of science tends to merge with the ethics of technology (see Heideggerian philosophy of science).

## 3 Anglo-American discussions

In contrast to the Continental approach, philosophers following an Anglo-American analytical tradition organize ethical discussions around particular technologies. For example, biomedical ethics includes the study of ethical implications of the use and development of advanced medical technologies (see Bioethics; Medical ethics); information technology ethics (also known as computer ethics) examines social and ethical ramifications of computers and high-speed digital networks (see Information technology and ethics); engineering ethics studies the professional responsibilities of engineers (see Engineering and ethics); and environmental ethics evaluates the effects of various technologies on the natural environment (see Environmental ethics). Work in these areas applies concepts and modes of analysis drawn from analytical moral philosophy and political theory even though, at times, the special problems of new technologies demand an extension of these concepts and methodology beyond their traditional usage.

Each sub-area of ethics and technology is marked by a distinctive community of discourse and unique set of issues. Nevertheless, a number of common themes cut across these specialized domains. Prominent among them are: equity or justice; the problem of risk; responsibility for technology; and the effect of technology on liberty and autonomy.

Historically, issues of social justice, related to the distribution of technological goods and services, were first to become a focus of moral concern. This set of issues played a major role in the nineteenth-century rise of the labour movement, socialism, and the state regulation of technology. More recently, equity issues have re-emerged in acute form in relation to biomedicine, environmental pollution and computers. On what basis should scarce medical resources such as donated or artificial organs be allocated? To what extent does protection of an environmental commons legitimately limit private ownership? How should access to information technologies be facilitated under democratic capitalist structures?

A different dimension of the problem of just distribution of technological benefits is the problem of the equitable distribution of technological costs and risks. The general problem of risk due to technology, however, goes beyond equity concerns, and is part of the more general effort of technology assessment. Technologies often have unintended consequences which, if known in advance, might have altered decisions about their adoption. These consequences may include an increase in risk. Two scholars who have especially influenced work in this area are David Collingridge (1980) and Kristin Shrader-Frechette (1991). Collingridge is well-known for his dilemma of technological (and risk) assessment: in the early development of a technology, when it is relatively easy to control its direction, we inevitably lack the knowledge to exercise reasonable control; yet by the time we have more experience and, along with it, a better understanding of the risks, control has become difficult, if not impossible. Shrader-Frechette argues that persons should not be subjected to technological risk until they have clearly understood the risk and have granted their consent without being unduly constrained by economic or other external pressures. She contends that the concept of free and informed consent as applied in the field of medicine is applicable to technology in general and ought to be a part of what guides morally grounded public policy (see Risk; Risk assessment).

The issue of responsibility for the effects of technology involves two dominant lines of inquiry. One is concerned with the special responsibilities of technical professionals (see Professional ethics). Paul Durbin (1992), for instance, argues that engineers have an obligation to go outside their technical communities to lobby public policy, as when physicists during the 1950s and early 1960s lobbied for a worldwide ban on the atmospheric testing of nuclear weapons or when computer scientists in the United States opposed funding of the Strategic Defense Initiative (the ‘Star Wars’ project) in the 1980s. The second line of inquiry focuses on questions of blameworthiness and accountability when technological innovations or products cause individual or societal harms (see Responsibility; Responsibilities of scientists and intellectuals §3).

Finally, invention and utilization of advanced technologies may be evaluated in terms of liberty and autonomy. In biomedicine, for example, in the name of liberty and autonomy, there have been numerous efforts to work out the exact parameters of free and informed consent, and then to propose ways to institutionalize them (see Consent). In the area of information technology, liberty and autonomy are a key to explaining normative dimensions of privacy as well as prescribing the extent of freedom of speech over the digital networks (see Privacy §2). Langdon Winner (1986) has discussed, in more general terms, the relationship of technology with control and autonomy by looking at ways in which the technological design process and large technical systems, such as roads, restrict human agency, affect political and personal autonomy and delimit the exercise of democratic citizenship.

## 4 Other approaches to ethics and technology

Political, economic, and social science studies of technology also often have ethical dimensions. For example, political science studies of the governmental regulation of technology and of law-technology relations have obvious implications for ethics. Not only public policy efforts at technology assessment, but attempts to develop scientific techniques of policy analysis ultimately reflect and influence ethical decision-making. The same is true for efforts to manage more effectively social investments in innovation at both the state and corporate levels, and even for welfare economics.

The ethical implications of social science approaches to technology centre around the issue of technological determinism, that is, the idea that technology is the primary determinant of social life, developing in an almost independent or autonomous manner. During the 1950s and 1960s, critics often opposed popular optimism about the unqualified benefits of technological progress with theories of technological determinism. Ironically, these theories almost immediately galvanized moral protest against technology. This protest was subsequently provided with theoretical justification by new studies that developed a social constructivist understanding of technological change, in which numerous agents and influences could be seen to exercise a series of micro-influences often invisible at the macro level (see Technology, philosophy of §4). Determinist and social constructivist interpretations, although apparently opposed, have quite similar moral implications. Both effectively highlight the continuing need for ethical examination of technology in a highly technological world.