In Philosophy of Technology The Technological Condition. Scharff, Robert. Malden, MA: Blackwell Publishing, 2003.

The Task of a Philosophy of Technology

Introduction

In spite of the relatively recent emergence of philosophies of technology, an impressive diversity of approaches has already developed In general, one can at least say that, not surprisingly, analytic philosophies of technology tend to reflect the characteristics of the predominantly empiricist-positivist tradition they inherit Hence, for example, given this tradition's well-established suspicion of speculative systems and extra-scientific claims, its philosophers of technology tend to look first toward actual, or real-world technological issues and problems and to eschew evaluations of anything like technology "as such " Also, given their tradition's long-standing preference for scientific, or at least science-like models of knowledge, analytic philosophers of technology usually take the scientific basis of modern technology for granted and concentrate on the ethical evaluation of the application of scientific knowledge in technology and by technologists Continental philosophies of technology, on the other hand, tend to reflect their tradition's long-standing suspicion of enlightenment conceptions of reason and of the scientistic and utopian attitude toward technology to which these conceptions have often led As a result, continental philosophies of technology frequently display considerable tolerance for holistic and extra-scientific evaluations of technological phenomena, and they rarely make a point of sharply distinguishing questions of the logic and facts of technology from questions of its value and valuation. All of these generalizations, however, are fairly high-level abstractions, and none of them capture adequately the plurality of actual positions Moreover, as the following selections make plain, not every philosophy of technology (e g , those inspired by classical pragmatism or by recent feminism) is easily classified under either the analytic or continental label

Analytical philosophy of technology is exemplified by the selection from Mario Bunge A former physicist and disciple of Karl Popper whose writings reveal a substantial commitment to general systems theory, Bunge has been a vocal participant in the so-called Science Wars alluded to in the previous section He is a passionate opponent of Romanticism and of anti-technological attitudes in philosophy generally and is also a severe critic of social constructivist and hermeneutical approaches to technology specifically In order to show that technology, when properly conceptualized, is not by nature "soulless, aphilosophical, or even antithetical to philosophy," Bunge describes the relations between technology and philosophy in terms of inputs and outputs (which is itself, of course, a technology-influenced terminology). On the output side, he notes that technology supplies system-theoretical ontologies (i e , conceptual systems of the nature of scientifically knowable objects like the one Bunge himself has produced in a multi-volume treatise) Technology, he adds, has also, and less fortunately, given us the philosophy of pragmatism As a disciple of Popper, Bunge is critical of pragmatism, at least as he understands it, but he admits it is clearly one of the major philosophies of the modern world (For a much more subtle and favorable estimation of pragmatism, see the article by Heelan and Schulkin in the previous section, chapter 13)

In the selections from various introductory notes to his famous *The Technological Society*, Jacques Ellul makes it plain that his approach to technology does not proceed by way of empirical descriptions of technological problems, techniques, and practitioners. Indeed, he suggests that such an approach will never arrive at an adequate conception of what technology is and how it functions. Only a characterization of "the real nature of the technological phenomenon" as a whole can shed light on its actual and pervasive – and, he thinks, also fundamentally dangerous – effect in the contemporary world. One especially provocative aspect of Ellul's approach, however, is that although it clearly exemplifies the global, or holistic outlook one expects from continental philosophers, he explicitly denies that this makes it either speculative or evaluative. His approach, he insists, is entirely "descriptive." Not only does he claim to deliberately avoid offering ethical and aesthetic evaluations of technology, he accuses those who read him as promoting a negative or pessimistic picture of technology as themselves simply reacting on the basis of their own prior (and extra-descriptive, "metaphysical") value commitments. Moreover, he argues that when critics accuse him of going beyond mere description in referring to "technology" itself as if it were a real phenomenon instead of, at best, a sociological abstraction, that simply reveals their commitment (common especially among non-continental philosophers) to methodological individualism. Philosophical "description" of technology cannot mean focusing only on individuals and their practices, because society is not simply the sum of actions of individuals, but has a collective reality. Without a proper account of this extra-individual character of the technological phenomenon, one will never understand its "deterministic" power in contemporary life and will therefore underestimate the extent to which we are currently deprived of our freedom by it.

Kristen Shrader-Frechette's well-known entry from the *Encyclopedia of Ethics* presents a clear summary of what is perhaps the most popular philosophical treatment of technology – indeed, one that is widely supposed to represent philosophy of technology's only task – namely, that of ethical evaluation. As Shrader-Frechette points out, there is considerable overlap between philosophers and non-philosophers in this area. For example, questions of the political and social responsibility of engineers and scientists, as well as risk-benefit analyses of technological projects and systems, are major concerns of policy scientists as well as (especially) analytic philosophers of technology.

In his essay, Hans Jonas resembles Ellul in presenting an unabashedly holistic account of the irreversibility and inevitability of technological change; but unlike Ellul, he combines this account with an appeal to shoulder the "cosmic task" of establishing ethical imperatives responsive to this change. Jonas distinguishes between the "formal dynamics" and the "substantive content" of technology. Formally, he argues, modern technology differs from premodern technology insofar as the former is "an enterprise and process," where the latter was more of "a possession and a state." Jonas stresses the fact that because modern technology is driven by consciously developed plans and ideas, its innovations tend to build upon one another sequentially and spread rapidly across the globe. In this way, a concept of technology as involving genuine progress – a concept in which invention and change are understood as bringing about conditions of life that are superior to those of the present or past – replaces the older idea of using technology to reach an accommodation with a static and stable natural order. Today, observes Jonas, the older "unilinear" idea of knowable but fixed ends and accommodating means, according to which good theory always precedes successful practice, has been replaced by a "circular" one. Science and technology have become inseparably intertwined (cf. Latour's reference to "technoscience"), and technological innovation is now just as likely to suggest new goals as advances in scientific knowledge. Jonas sees the inherent "restlessness" of modern science and technology as leading to the disastrous situation where the sheer process of production and alteration of objects and objectives itself becomes the end of life, thus threatening any substantial and extra-technoscientific idea of what we are like and what life is for. Hence, our most urgent philosophical need is for an ethics of averting disaster – an ethics that encourages a world in which diverse images of humanity and the quality of life legitimately contend, and people in power are as little beholden as possible to the interests generated by technology. Yet one must ask, says Jonas, echoing the problem Plato's philosopher king faces in the *Republic*, Book 7 (see chapter 1), what the role of the philosopher can be in such a world, and one must consider the inevitable compromises that a well-meaning person will have to make in order to be effectively involved in public policy-making.

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Philosophical Inputs and Outputs of Technology

Mario Bunge

Technology is often considered soulless, aphilosophical, or even antithetical to philosophy This paper contends that such an image of technology is erroneous and that:

1 Far from being aphilosophical, let alone antiphilosophical, technology is permeated with some of the philosophy it has inherited from pure science along with scientific methods and theories – as exemplified by its reliance on the philosophical principle that we can get some knowledge of reality through experience and reason, and even improve on it

2 Far from being philosophically passive or sterile, technology puts forth a number of philosophically significant theories, such as automata theory, and important (though perhaps mistaken) philosophical views, such as pragmatism

3 Far from being ethically neutral, like pure science, technology is involved with ethics and wavers between good and evil

In other words, this paper proposes the thesis that technology has a philosophical input and a philosophical output and, moreover, part of the latter controls the former If this is true, then technology is not cut off from culture nor is it a detachable part of culture; technology is instead a major organ of contemporary culture This being so, the philosopher must pay it far more attention than before; he should build a fully developed philosophy of technology related to but distinct from the philosophy of science

From *The History of Philosophy and Technology*, ed George Bugliarello and Dean B. Doner, Urbana: University of Illinois Press, 1979, pp. 262–81, abridged. Reprinted by permission of George Bugliarello

Tasks of the Philosophy of Technology

The concern of the philosophy of technology – one of the underdeveloped areas of philosophy – is the investigation of the philosophy inherent in technology as well as of the philosophical ideas suggested by the technological process Some of the typical problems in the philosophy of technology are these: (a) Which characteristics does technological knowledge share with scientific knowledge, and which are exclusive of the former? (b) In what does the ontology of artifacts differ from that of natural objects? (c) What distinguishes a technological forecast from a scientific forecast? (d) How are rule of thumb, technological rule, and scientific law related? (e) Which philosophical principles play a heuristic, and which a blocking, role in technological research? (f) Does pragmatism account for the theoretical richness of technology? (g) What are the value systems and the ethical norms of technology? (h) What are the conceptual relations between technology and the other branches of contemporary culture?

Where are we to search for the philosophical components of technology? Clearly not among the products of technology – cars, drugs, healed patients, or victims of technological warfare – which are about the only technological items the anti-technological philosopher is acquainted with We must search for philosophy among the ideas of technology – in technological research and in the planning of research and development. We are likely to find them here, as philosophy is found in every department of mature thinking. Indeed mature thinking is always guided (or misguided) and controlled (or exhilarated) by methodological rules as well as by epistemological, ontological, and ethical principles. Just think of the problems posed by the design of any new product. Is the relevant scientific knowledge reliable, and is it likely to be sufficient? Will the new product be radically new – that is, will it exhibit new emergent properties – or will it be just a rearrangement of existing components? Shall we design the product so as to maximize performance, social usefulness, profit, or what?

Since the philosophical components of technology must be searched for among technological ideas, we had better start by recalling what the loci of these ideas are. Moreover, since there is some uncertainty about what "technology" includes, we should enumerate the branches of technology as we understand it.

Branches of Contemporary Technology

We take technology to be that field of research and action that aims at the control or transformation of reality whether natural or social. (Pure science, if it is experimental, also controls and transforms reality but does so only on a small scale and in order to know it, not as an end in itself. Whereas science elicits changes in order to know, technology knows in order to elicit changes.) We discern the following branches of technology;

Material	Physical (civil, electrical, nuclear, and space engineering) Chemical engineering Biochemical (pharmacology) Biological (agronomy, medicine)
Social	Psychological (education, psychology, psychiatry) Psychosociological (industrial, commercial, and war psychologies) Sociological (politology, jurisprudence, city planning) Economic (management science, operations research) Warfare (military science)
Conceptual	Computer sciences
General	Automata theory, information theory, linear system theory, control theory, optimization theory, and so forth

This list is not exhaustive, and some technologists may feel ill at ease with the bed fellows I have chosen for them. The list is intended to be only a partial extensional definition of "technology." It includes the miscellany I have called "general technology" because its theories can be applied almost everywhere regardless of the kind of system; we shall see later in the paper that it constitutes the great contribution of technology to metaphysics. On the other hand, the list does not include futurology, because the latter is just long-term planning and hence is part of social technology.

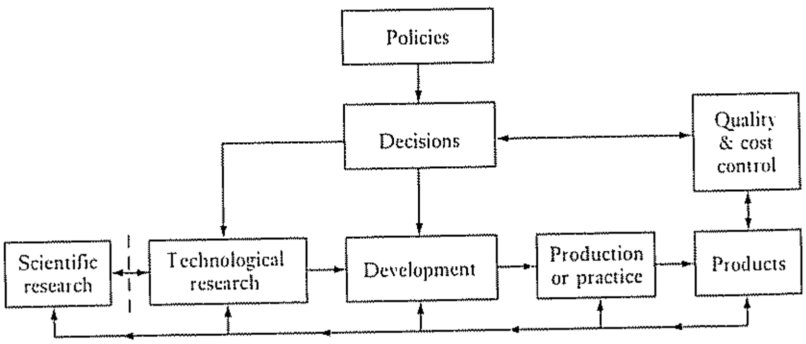

Figure 1 Flow Diagram of Technological Process. The first stage, scientific research, is occasionally missing or completed at a scientific institution – hence the dotted vertical line. The end product of a technological process need not be an industrial good or a service; it may be a rationally organized institution, a mass of docile consumers of material or ideological goods, a throng of grateful if fleeced patients, or a war cemetery.

Let us now locate the areas of maximal conceptual density regardless of subject matter: there we must cast our net To this end we must take a brief look at the technological process

Technological Research and Policy

A technological process exhibits the stages shown in Figure 1.

Most technological ideas are found in two of the stages or aspects of a technological process: policy and decision making (largely in the hands of management) and research (in the hands of investigators) In any high-grade technological process, such as one taking place in a petroleum refinery, in a hospital, or in an army, managers as well as technological investigators (but not technicians and blue- and white-collar workers) employ a number of sophisticated conceptual tools – belonging, for example, to organic chemistry or operations research If they are innovative or creative, policy makers and investigators will try out or even invent new theories or procedures. In sum, technology is not alien to theory, nor is it just an application of pure science; it has a creative component, which is particularly visible in the design of technological policies and in technological research

Consider technological research for a moment Methodologically, it is no different from scientific research. In either case, a research cycle looks schematically like this: (1) spotting the problem; (2) trying to solve the problem with available theoretical or empirical knowledge; (3) if that attempt fails, inventing hypotheses or even whole hypothetico-deductive systems capable of solving the problem; (4) finding a solution to the problem with the help of the new conceptual system; (5) checking the solution, for example by experiment; (6) making the required corrections in the hypotheses or even in the formulation of the original problem Besides being methodologically alike, both kinds of research are goal-oriented; however, their goals are different The goal of scientific research is truth for its own sake; that of technological research is useful truth

The conceptual side of technology is neglected or even ignored by those who equate technology with its practice or even with its material outputs (Curiously enough, not only idealist philosophers but also pragmatists ignore the conceptual richness of technology Hence neither of them can be expected to give a correct account of the philosophy inherent in technology) We must distinguish the various stages or aspects of the technological process and focus on technological research, as well as on the design of technological policies, if we are to discover the philosophical components of technology.

Before we face our specific problem we shall make one more preliminary investigation – this time into the conceptual relations among technology and a few other branches of culture, both alive and dead

Near Neighbors of Technology

Nothing, especially not technology, comes out of nothing Hence nothing, especially not technology, can be understood in isolation from its kin and neighbors Modern technology grows out of the very soil it fertilizes, industrial civilization and modern culture The distinction between civilization and culture is particularly useful for understanding the nature of technology One can have some modern industry without modern culture, provided one imports technological know-how and does not expect great technological innovations One can have scraps of modern culture without modern industry – provided one is willing to put up with a one-sided and rickety culture No creative technology, however, is possible outside modern civilization (which includes modern industry) and modern culture (which of course includes modern technology)

In particular, modern technology presupposes not only ordinary knowledge and artisanal skills but also scientific knowledge, hence mathematics Technology is not a final product, either; it shades into technical practice – the practice of the general practitioner, the teacher, the manager, the financial expert, or the military expert Things are not completely pure in or around technology; besides its artistic and philosophical components, one occasionally finds traces of pseudoscience and pseudotechnology Table 1 shows some of the nearest neighbors of technology To complete the picture, add mathematics, crafts, arts, and humanities, as in Figure 2, below

Having sketched a map of technology and having listed some of its neighbors very schematically, we are now in a position to try to explore the philosophy inherent in technological research and policy making

Table 1. The nearest neighbors of technology

PROTOSCIENCE	SCIENCE	TECHNOLOGY	TECHNICAL PRACTICE	PSEUDOTECHNOLOGY
Ancient & medieval physics & astronomy	Modern physics & astronomy	Physical engineering	Engineering practice	Astrology
Ancient & medieval mineralogy & part of alchemy	Chemistry	Chemical engineering	Chemical engineering practice	Alchemy
Ancient & medieval natural history	Biology	Agronomy, medicine	Agrotechnical & medical practices	Homeopathy, chiropractic, Lysenkoism
Philosophy of mind (partly)	Psychology	Psychopathology	Drug & behavior therapy	Psychoanalysis, graphology
	Economics	Economic & financial planning	Economic management	Economic miraclemanship
		Computer science	Computation & control	GIGO computeering

The Epistemology of Technology

Technology shares with pure science a number of epistemological assumptions. We mention only the following: (1) there is an external world; (2) the external world can be known, if only partially; (3) every piece of knowledge of the external world can be improved upon if only we care to. These assumptions belong to epistemological realism. The classical technologist was not only a realist but usually a naive realist, in that he took our representations of reality for more or less accurate pictures of it. The modern technologist, involved as he is with constructing sophisticated mathematical models of things and processes, is still a realist but a critical one. He realizes that our scientific and technological theories are not pictures but symbolic representations that fail to cover every detail (and sometimes the very essence) of their referents. He knows that those theories are over-simplifications and also that they contain many concepts – like the proverbial massless piston – which lack real counterparts.

However, the critical realism of technology is tempered and distorted by a strong instrumentalist or pragmatist attitude, the normal attitude among people intent on obtaining practical results. This attitude is obvious from the technologist's way of dealing with both reality and the knowledge of it. For him, reality, the object of pure science, is the sum total of resources (natural and human), and factual knowledge, the aim of pure science, is chiefly a means.

In other words, whereas for the scientist an object of study is a *Ding an sich*, for the technologist it is a *Ding für uns*. Whereas to the scientist knowledge is an ultimate goal, to the technologist it is an intermediate goal, something to be achieved only in order to be used as a means for attaining a practical goal. It is no wonder that instrumentalism (pragmatism, operationalism) has such a great appeal both to technologists and to those who mistake technology for pure science.

Because of his pragmatic attitudes, the technologist will tend to disregard any sector of nature that is not or does not promise to become a resource. For the same reason he is prone to push aside any sector of culture unlikely to be instrumental for achieving his goals. This is just as well as long as he is open-minded enough to tolerate whatever he disregards.

The pragmatic attitude toward knowledge is reflected, in particular, in the way the technologist treats the concept of truth. Although in practice he adopts the correspondence conception of truth as adequacy of the intellect or mind to the thing, he will care for true data, hypotheses, and theories only as long as they are conducive to the desired outcomes. He will often prefer a simple half-truth to a complex truth. He must, because he is always in a hurry to get useful results. Besides, any error made in neglecting some factor (or some decimal figure) is likely to be overshadowed by unpredictable disturbances his real system may undergo. Unlike the physicist, the chemist, or the biologist, he cannot protect his systems against shocks other than by building shock-absorbing mechanisms into them. For similar reasons, the technologist cannot prefer deep but involved theories when superficial ones will do. However, unless he is a pseudotechnologist, he will not shy away from complex and deep theories if they promise success. (For example, he will employ the quantum theory of solids in the design of solid state components and genetics in obtaining improved varieties of corn.) The technologist, in sum, will adopt a mixture of critical realism and pragmatism, varying these ingredients according to his needs. He will seem to confirm first one and then another epistemology, while actually all he intends to do is to maximize his own efficiency regardless of philosophical loyalties.

The technologist's opportunistic conception of truth is just one – although major – epistemological component of technology. We shall now cite two specific items of epistemology that have taken part in technological developments, one in education, the other in artificial intelligence. It is well known that Pestalozzi's educational techniques were based on the slogan of British empiricism, "No concept without a percept." Likewise the philosophical basis of Dewey's educational techniques was the pragmatist thesis, "No concept without an action." The philosophy underlying artificial intelligence studies contains one major ontological hypothesis, "Whatever behaves like an intelligent being is intelligent," and a batch of epistemological hypotheses, among them "Every perception is the acceptance of an external stimulus" and "Some spatial patterns are perceptible and discrete."

There is more to the epistemology of technology, but we must hurry on to the metaphysics of technology.

The Metaphysics of Technology

Technology inherits some of the metaphysics of science and has in turn produced some remarkable metaphysics of its own. We shall list without discussion a few examples of each.

Here are some of the metaphysical hypotheses inherent in both scientific and technological research:

1. *The world is composed of things*, that is, it is not simple, and it is not made of ideas or of shades of ideas. (Were this not so, we could not get things done by cleverly manipulating things – people among them. Mere wishes or incantations would suffice.)
2. *Things get together in systems* (composed of things in more or less close interaction), and *some systems are fairly well isolated from others*. (Otherwise we would not be able to assemble and dismantle things, nor would we be capable of acting upon anything without at the same time disturbing everything else.)
3. *All things, all facts, all processes, whether in nature or in society, fit into objective stable patterns (laws)*. Some of these laws are deterministic, others are stochastic, and all are objective. (Otherwise we would not need to know any laws in order to transform nature and society: ordinary knowledge would have sufficed to bring forth modern technology.)
4. *Nothing comes out of nothing and nothing goes over into nothingness*. There are antecedents or causes for everything, and whatever is the case leaves some trace or other. If this were not so, there should be no need to work and no worries about energy.
5. *Determination is often multiple and probabilistic rather than simple or linear*. (If this were not so, we would be unable to attain most goals through different means, and there would be no point in searching for optimal means or in calculating probabilities of success.)

So much for the metaphysics that takes part in technological research and policy making. Now let us look at some of the metaphysical outputs of contemporary technology. While some of them are loose though important theses, others are full-blown ontological theories. Among the former we point out the following:

1. With the help of technology man can alter certain natural processes in a deliberate and planned fashion.
2. Thanks to technology man can create or wipe out entire natural kinds, thus increasing the variety of reality in some respects and decreasing it in others.
3. Because artifacts are under intelligent control or are endowed with control mechanisms which have not emerged spontaneously in a

process of natural evolution, they constitute a distinct ontic level characterized by properties and laws of its own – whence the need for elaborating a technological ontology besides the ontologies of natural and of social science As for the metaphysical theories evolved by contemporary technology, they belong in what I have called general technology. They are high grade (though mathematically often simple) general theories such as automata theory, the general theory of machines, general network theory, linear system theory, information theory, control theory, and optimization theory They qualify not only as technological (or scientific) theories but also as ontological theories for the following reasons. First, they are concerned with generic traits of entire genera (rather than species) of systems: they are cross-disciplinary theories (Think of the variety of applications of automata theory and control theory) Second, those theories are stuff-free (independent of any kind of material), hence independent of any particular physical or chemical law (They focus on structure and behavior rather than on specific composition and mechanism.) Third, those theories are untestable without further effort, if only because they issue no predictions (They can be made to issue projections and thus become testable upon conjoining them with items of specific information concerning the concrete systems they are applied to.)

In sum, whether they like it or not technologists have built a conceptual building which houses all of the metaphysics of science plus some distinctly technological metaphysics. Metaphysics, banned from philosophy departments, is alive and well in the schools of advanced technology.

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The Value Orientation of Technology

To the scientist all concrete objects are equally worthy of study and devoid of value Not so to the technologist: he partitions reality into resources, artifacts, and the rest – the set of useless things He values artifacts more than resources and these in turn more than the rest His, then, is not a value-free cosmology but one resembling the value-laden ontology of the primitive and archaic cultures One example should suffice to bring this point home

Let P and Q be two components or properties of a certain system of technological interest Assume that, far from being mutually independent, Q interferes with or inhibits P If P is desirable (in the eyes of the technologist) then Q will often be called an impurity. Unless the impurity is necessary to obtain a third desirable item R (such as conductivity, fluorescence, or a given color), the technologist will regard Q as a disvaluable item to be minimized or neutralized. To the scientist Q may be interesting or uninteresting in some respects, but never disvaluable.

This value orientation of technological knowledge and action contrasts with the value neutrality of pure science. True, social science does not ignore values but attempts to account for them However, to pure science nothing is either pure or impure in an axiological sense, not even pollutants. In pure science valuation bears not on the objects of study but on the research tools (e g , measurement techniques) and outcomes (e.g., theories) One lunar theory may be better (truer) than another, but the moon is neither good nor bad That is not so for the space scientist and the politician behind him Whereas the technologist evaluates everything, the scientist *qua* scientist evaluates only his own activity and its outcomes. He approaches even valuation in a value-free fashion.

The value orientation of technology gives the philosopher a splendid opportunity to analyze the valuation process in concrete cases rather than setting up a priori (or else conventional) "value tables." It can even inspire him to build realistic value theories, where valuation appears as a human activity, largely rational, done in the light of definite antecedent knowledge and definite desiderata. As a matter of fact, technology has already had an impact on value theory; utility theory (the theory of subjective value), though originally proposed as a psychological theory, has recently been revived and elaborated in response to the needs of managers One may also think of a theory of objective value even more closely in tune with technology – one defining value as the degree of satisfaction of an objective need.

We turn now to a few other instances of the impact of technology upon philosophy

Technology as a Source of Inspiration for the Philosophy of History

We have seen that technology is both a consumer and a producer of philosophical ideas In addition, it can inspire or suggest interesting new developments in the philosophy of action, in particular ethics, legal philosophy, and the philosophy of history Let us look into the last

A number of historians are applying mathematics to problems in history Here are a few examples of the mathematization of history: (a) cleansing historical data (such as chronologies) with the help of mathematical statistics; (b) finding historical trends or quasi-laws in a number of socioeconomic variables (notably by the French historians of the *Annales: Economies, Sociétés, Civilisations*); (c) building mathematical models of certain historical processes, such as the expansion and decline of empires; and (d) studying certain historical events and processes in the light of decision theory This last approach, suggested partly by management science, is legitimate with reference to deliberate decisions affecting the life of entire communities. The passing of important new legislation, the launching of a war, the call to a nationwide strike, and the outbreak of a planned revolution are occasions for the application of decision theory. Indeed, all the necessary components are there or can be conjectured: the decision makers who are supposed to maximize their expected utilities, the goals, the utilities of them, the means or courses of action considered by the decision makers, and the probability of attaining a given goal with a certain means.

The philosophy of history can acquire a whole new dimension in the light of decision theory, provided, of course, it is not employed to resurrect the great hero theory of history Certainly, important areas of historiography, such as the anonymous history studied by historical demography, historical geography, and economic history, remain beyond the decision-theory approach. However, in an increasingly technological society, rational (but, alas, often wicked) action, based on carefully designed policies, plays an increasingly important role and can therefore be partly understood with the help of decision theory.

Technology as a Source of Inspiration for Ethics and Legal Philosophy

Other fields of the philosophy of action that technology can fertilize are ethics and legal philosophy, by teaching them to spell out norms as grounded rules or even as conclusions of arguments Thus, instead of issuing blind commands of the form "Do *x*," or blind ethical norms of the form "You ought to do *x*," the technologist will proceed as follows He will propose and test grounded rules of the form "Do *x* in order to get *y*," on the basis of the knowledge that doing *x* does in fact bring about *y* either invariably or with a certain probability By stating explicitly the ground for a rule of action, one kills three birds with one stone: (a) one breaks the fact/norm barrier, (b) one transforms moral decision making into a rational activity, and (c) one dispenses with the logic of norms

This proposal, even if feasible, does not allow us to build a value-free ethics. This would be impossible, because moral decision making is as value-oriented as technological policy design What technology can teach us is, rather, to render values explicit so as to be able to examine them critically instead of receiving them uncritically In other words, it is impossible to translate a normative sentence into a value-free declarative sentence without loss On the other hand, it is possible to spell out a norm into a pair law sentence-value sentence, in this way: "Do *x*" or "You ought to do *x*" may be construed as short for "There is a *y* such that *x* brings about *y* and (you value *y* or there is a *z* such that not doing *x* brings about *z* and you disvalue *z*)." The command (or the norm) and its expansion, though not logically equivalent, are related in that the former is just an abbreviation of the latter

For example, "Do not cheat" can be expanded into "(Any) cheating does (some) harm and you do not want to do any harm " But the same norm can also be expanded into "(Any) cheating jeopardizes your credit and you want to keep your credit in good standing." This ambiguity is to be blamed on the norm itself and not on its rational translation In any event, a norm, when grounded and formulated in the declarative mode, appears as a consequence of a set of premises. And at least one of these premises is a law statement while at least one other is a value judgment. Consequently, the handling of norms requires only ordinary logic (instead of the logic of norms) and value theory In other words, we can reconstruct normative science without norms, but with values

(Superficially, ordinary logic would seem to suffice Thus, in the case of the injunction not to cheat because it causes harm and harm is undesirable, we would seem to have just an instance of *modus tollens*, namely: $C \rightarrow H \;\&\; \neg H \;.\; \neg C$ However, the H occurring in the first premise differs from that H occurring in the second: the latter is not really H but rather "H is valuable " Likewise, the conclusion is a value statement A task of value theory is to compute the value of the conclusion in terms of the values occurring in the premises But we cannot go into this here.)

What holds for ethics holds for legal philosophy: here, too, norms are profitably expanded into complex statements or construed as consequences of sets of premises For example, "Murderers must be put away" somehow follows from "Murder endangers the social structure and we value the social structure " However, the same norm also follows from premises in a different field, e g , "Murderers are sick people and it is disvaluable to leave sick people at large," as well as from premises inspired in still other value systems The advantage of such expansions is obvious: they force the law giver to lay bare the grounds of positive law – which is often cruel, unfair, or even absurd – and invite him to ground legal technology on sociology and psychology

In sum, technology suggests that we replace every authoritarian set of imperatives with a grounded set of rules – rules based on laws and value judgments In this way, whatever was implicit or even concealed can be analyzed, criticized, reconstructed, and systematized Technology can thus act as a methodological model for the normative sciences, in particular ethics Unfortunately, far from having served as a moral model, technology is in need of some ethical bridling This deserves another section

The Dubious Morals of Technology

Knowing is a good in itself (Even knowing how to inflict pain may be valuable, as it can assist us in avoiding the act of inflicting pain) However, there are ways and means of knowing, and some of them may be morally objectionable, such as torturing and killing people in order to find out more about fear Hence scientific research gets somewhat involved with ethics In practice, a few rather obvious strictures usually suffice to keep it unsoiled There are, of course, uncertainty zones, but they can be bounded For example, in research into fear mild torturing might be condoned provided it is done with the free consent of the experimental subject and it can be safely predicted that it will not be traumatic In short, pure science needs only a mild external ethical control As a matter of fact, scientific research has built into it an ethical code of honesty, responsibility, and hard work that can inspire other human activities

Things are different in technology Here not only some of the means and ways of knowing may be impure, but also the entire technological process may be morally objectionable for aiming exclusively at evil practical goals For instance, it is wicked to conduct research into forest defoliation, the poisoning of water reservoirs, the maiming of civilians, the manipulating of consumers or voters, and the like, because the knowledge gained in research of this kind is likely to be used for evil purposes and unlikely to serve good purposes It is not just a matter of an unexpected evil use of a piece of neutral knowledge, as is the case with the misuse of a pair of scissors: the technique of evil doing is evil itself The few valuable items it may deliver are by far outnumbered by its negative output Try to find a good use for the stocks of lethal germs accumulated for chemical warfare, for example, or for plans for the rational organization of an extermination camp

Technology can then be either a blessing or a curse That it is always a blessing, if not in the short run then in the long run, is a tenet which has been preached by a number of progressive philosophers since the dawn of the modern period Other philosophers claimed instead that technology is a curse, but they did so for the wrong reasons – because they were against social progress and cultural expansion It is only very recently that most of us have come to realize that technology itself can in fact be wicked and must therefore be checked We have learned that, while accelerating advance in some respects (such as the size of the GNP), technology is also accelerating our decline in other respects (such as the quality of life) and is even jeopardizing the very existence of the biosphere

Of course, there is nothing unavoidable about the evils of technology Except for isolated cases of unexpected bad side effects, technology could be all good instead of being half-saintly and half-devilish It is up to the policy makers to have the technological investigator produce good or evil technological items It is up to the technologist to take orders or to disobey them In any event, technology is by its nature morally committed one way or another, and it needs some ethical bridling

The Ethics of Technology

Every human activity is either explicitly controlled or criticizable by some behavior code which is partly legal and partly moral In particular, the technological process has usually been guided (or misguided) by the following maxims:

1 Man is separate from and more valuable than nature
2 Man has a right (or even the duty) to subdue nature to his own (private or social) benefit
3 Man has no responsibility toward nature: he may be the keeper (or even the prison warden) of his brother, but he is not the nanny of nature
4 The ultimate task of technology is the fullest exploitation of natural and human resources (the unlimited increase in GNP) at the lowest cost without regard for anything else
5 Technologists and technicians are morally irresponsible; they are to carry on their task without being distracted by any ethical or aesthetic scruples. The latter are the exclusive responsibility of the policy makers

These maxims constitute the core of the ethics of the technology that has prevailed heretofore in all industrial societies, regardless of the type of social organization. Certainly those maxims are not justified by technology itself: rather, they justify boundless exploitation of the natural and social resources. Moreover, they have not evolved within technology or science but within certain religions, ideologies, and philosophies.

In recent years we have come to distrust these maxims or even reject them altogether because we have started to realize that they condone the dark side of technology. As yet, we have not offered an alternative ethical code. It is high time we attempted to build alternative ethics of technology, ones with different desiderata and based on our improved knowledge of both nature and society, which were largely unknown at the time the old code was formulated, toward the beginning of the seventeenth century. If we wish to keep most of modern technology while minimizing its evil components and negative side effects, we must design and enforce an ethical code for technology that covers every technological process and its repercussions at both the individual and the social levels. Such a code should consist of the following components: (1) *An individual ethical code* for the technologist *qua* investigator. This should include the ethics of science, namely the set of ethical norms securing the search for truth and its dissemination. It should also take into account the peculiar moral problems faced by the technologist bent on attaining noncognitive goals. These additional norms should emphasize the personal responsibility of the technologist in his professional work and his duty to decline taking part in any project aiming for antisocial goals. Such moral imperatives, or rather grounded rules, should be consistent with (2) *a social ethical code* for technological policy making, research, and development of practices, disallowing the pursuit of unworthy goals and limiting any technological processes that, while pursuing worthy goals, interfere severely with further desiderata. This social ethical code should be inspired by the overall needs and desiderata of society rather than being dictated by any privileged group within it. Otherwise it would be unfair, and it might not be enforceable.

Such a two-tiered ethical code would make impossible, or at least reprehensible, the "Dr Jekyll-Mr Hyde" type of scientist who deserves both the Nobel prize for his contributions to elementary particle research and a hanging verdict for designing diabolical new means of mass murder. There would be no toleration of double ethical standards today if there were not two ethical codes, one for the pure scientist and the other for the impure technologist. If we are to keep technology in check, we need a single ethics of technology covering its whole wide spectrum, from knowledge to action.

Conclusion: The Centrality of Technology

Nobody denies that technology is central to industrial civilization. What is sometimes denied is that technology forms an essential part of modern intellectual culture. Indeed, it is often held that technology is alien or even inimical to culture. This is a mistake, one which betrays a total ignorance of the intellectual richness of the technological process, in particular of the innovating one. The mistake has obnoxious consequences, for it perpetuates the training of scholars with a traditional (preindustrial) cast of mind and conceptual equipment, contemptuous and afraid of whatever they do not understand about modern life. When they wield power in governmental or educational institutions, such people try to isolate the technologist as a skillful barbarian who must be kept in his modest place as the provider of material comfort. By behaving in this way, those scholars in fact deepen the gaps among the various subcultures and miss the chance of contributing to steering the course of technology along a path beneficial to society as a whole.

Like every other culture, ours is a complex system of heterogeneous interacting components. Some of them are already past their creative prime, others are blossoming, while still others are just budding. The creative components of our culture are some of the humanities, mathematics, science (natural and social), technology, and the arts. Modern technology is both an essential component and the youngest of all. Perhaps this is why we do not fully realize how central it is to our culture. In fact, instead of being an isolated component, technology interacts strongly with every other branch of culture. (On the other hand, art hardly interacts at all with mathematics.) Moreover, technology and the humanities (in particular philosophy) are the only components of living culture that interact vigorously with all the other components (see Figure 2). In particular, technology interacts fairly strongly with several branches of systematic philosophy: logic, epistemology, metaphysics, value theory, and ethics.

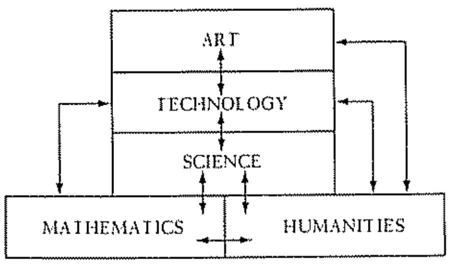

Figure 2 Flow Diagram of the System of Contemporary Culture. The noncreative components have been discarded.

Not only does technology interact with every other living sector of contemporary culture, in particular philosophy, but it overlaps partially with some of them. Thus, architecture and industrial design are at the intersection of technology and art; much of physics and chemistry is as much engineering as it is science; applied genetics is hardly distinguishable from pure genetics; and even some of metaphysics is at the intersection of technology and philosophy, as was discussed above.

Like science, technology consumes, produces, and circulates philosophical goods. Some of these are the same as those activated by science; others are peculiar to technology. Thus, because of its emphasis on usefulness, the epistemology of technology has a pragmatist streak and is therefore coarser than the epistemology of scientific research. On the other hand, the metaphysics and the ethics of technology are richer than those of science.

Because of the conceptual richness of technological processes, and because of the multiple contacts between technology and the other creative components of modern culture, technology is central to that culture. We cannot ignore the organic integration of technology with the rest of modern culture if we wish to improve the health and even save the life of our culture. We cannot afford to ignore the nature of technology, let alone despise it, if we want to gain full control over technology in order to check its dark side. We must then build up all the disciplines dealing with technology, not least of them the philosophy of technology – the more so since it is often mistaken for the philosophy of science. The history, sociology, and psychology of technology tell us much about technologies and technologists, but only the philosophy of technology makes it its business to tell us what the methodological, epistemological, metaphysical, and ethical pennants of technology look like.