THINKING ABOUT TECHNOLOGY

Foundations of the Philosophy of Technology

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Preface

IT ALMOST GOES WITHOUT SAYING that technology is a pervasive feature of contemporary culture. In this book I will be arguing, among other things, that technology is more than that; it is a defining feature of the human condition. It is, therefore, the job of philosophy, the form of inquiry best suited to focusing our thinking about the "big" questions, to make sense of technology and to help us understand its workings as well as its impacts on our lives and values.

Unfortunately, the kind of attention that contemporary philosophers usually give to matters of technology consists primarily of social criticism. Post-World War II philosophical treatments of technology have been primarily negative, taking the form of critical denunciations of the negative effects of technology on human values and on human life. On the whole, social criticism is a perfectly respectable aspect of philosophical work. Most social criticism of technology comes in one of three forms: (a) critiques based primarily on ideological considerations, e.g., Marxists or Earth-Firsters; (b) critiques based on projections of the consequences of not rejecting a technology or developing a new technological project, e.g., huge dams or nuclear reactors; (c) a combination of (a) and (b). In what follows I will have something to say about each form of social criticism. Briefly, with respect to (a), I argue that ideological critiques contribute little to rational consideration of the merits or demerits of a technology. With respect to (b), I am most concerned to argue that we need to assess our epistemological assumptions (about, for example, the reliability of forecasting techniques used to predict the consequences of specific technological innovations or changes) before we go on to use various claims generated in the context of those assumptions as the basis for a critical assessment of the merits of the technology in question. On a more fundamental level, the level with which I am most concerned, we need to know how to evaluate, for example, a technological explanation, before we go on to use that explanation as the basis for a critical assessment of the merits

of the technology in question. Knowing how to evaluate an explanation is essentially an epistemological (and perhaps a logical) problem (depending on the type of explanation).

This book presents a case for the logical priority of epistemological issues over social criticism in the "order of knowing." Understanding what we know about technology, and understanding *how we know that what we know is reliable*, are the prerequisites to offering sound evaluation of the effects of technologies and technological innovations on our world and on our lives.

There is another reason for insisting on the priority of epistemological questions in philosophical discussions of technology. This has to do with the nature of philosophy as an activity in itself. Philosophy aims at explaining how everything "hangs together," at showing how values and hopes for the way things should be either affect, ignore, improve on, or debilitate the way things are. Philosophy tries to explain the world by explaining the interrelatedness of all its parts, both the way it is and the way we would like it to be. It is important, therefore, that philosophical explanations assist this process. As it happens, the social critics of technology do not provide analyses that can be used in this way, for they begin by assuming a privileged point of view about the way things ought to be, rendering their conclusions and their analyses incapable of handling such not-so-trivial questions as: How do you know you are right? Whatever else it is, philosophy must be self-critical. It has no one single methodology, but even so, whatever methodology is employed must be capable of reflexivity.

The word "philosophy" in its original Greek meant love of wisdom. It does not follow now (nor did it for the Greeks) that one who practiced or practices philosophy is wise, nor does it follow that the result of philosophizing is wisdom. Loving wisdom does not necessarily make you wise, just as loving beauty does not make you beautiful. To do philosophy is be engaged in the *search* for wisdom. Considered this way, philosophy is not so much a body of truths as a *process* or a means of exploring. The history of philosophy is the history of that search, and it can be seen as having the form of a dialogue. It is a discussion with participants drawn from the present and the past on issues of long-term human concern.

Viewing the history of philosophy as a dialogue has its advantages and disadvantages. One advantage is that the concerns of philosophers can best be made sense of when viewed in context. On the other hand, understanding philosophy as a dialogue can be frustrating. The frustration comes not only from the amount of time it takes to complete some aspect of the dialogue, but also because the questions change over time. And while discussions of the general issues range over epochs, it is also true that things change over time. In philosophy, the importance, meaning, and viable

solutions to these long-lasting issues also change as the culture changes. The result is that philosophy is a *continuing* and *dynamic* dialogue.

Well then, you may ask, what is the difference between philosophy and any other discussion? The difference has to do with the aim of philosophy. Perhaps the most eloquent and provocative account of the aim of philosophy was put forth by Wilfrid Sellars. As we will see, Sellars sets his sights rather high. From a philosophical point of view, however, there is nothing wrong with aiming high. In fact, settling for less than the most we can conceive of is what should be avoided. Philosophy, then, in the words of Wilfrid Sellars, is concerned

> to understand how things in the broadest sense of the term hang together in the broadest sense of the term. Under 'things in the broadest possible sense' I include such radically different items as not only 'cabbages and kings,' but numbers and duties, possibilities and finger snaps, aesthetic experience and death. To achieve success in philosophy would be, to use a contemporary turn of phrase, to 'know one's way around' with respect to all these things, not in that unreflective way in which the centipede of the story knew its way around before it faced the question, 'how do I walk?' but in that reflective way which means that no intellectual holds are barred. (Sellers 1963, 1)

It should be obvious why I think Sellars is aiming too high. Except perhaps for Aristotle, up to this point no one has managed to make complete sense of the way things are. This is not to say that no one has tried. Quite the contrary, the history of philosophy is the history of our efforts to achieve that very goal. The fact remains, however, that no completely satisfactory philosophical system has been produced. That is, we have yet to produce a system that meets Sellars' conditions. There are many reasons for this failure, some of which we will consider below. But, returning briefly to the role of questions about technology in the philosophical dialogue, to use the lack of a satisfactory philosophical system as an explanation of the failure of philosophers to come to grips with technology takes the cheap way out; on those grounds, since no one has succeeded in making sense of everything taken together, nothing has been explained at all.

But, as we are well aware, it is simply not true that nothing has been explained. For example, we find that scientific inquiry continues to help us make increasing sense of the structure of the universe and our place in it as physical beings. Historical and cultural studies continue to examine and probe the significance of humanity and its works in and over time. And while no complete picture has emerged that truly accomplishes what Sellars set as the goal of philosophy, it just may be that this is due to the

incompleteness of our understanding. Some of the things we have yet to appreciate fully are the complexity of humanity's own activity, the ways in which we respond to the environment that we are continually changing, and the effects of our impact on the environment on us. That, plus the complexity of the universe, makes a completely systematic and comprehensive explanation of "life, the universe, and everything" utopian.[1] That our goal is utopian does not mean that it should be abandoned and that we should give up trying to explain the universe and our place in it. While it might be true that we should abandon some goals, such as trying to fly without physical assistance, it does not follow that all goals beyond our immediate reach should be abandoned, even if they are in principle beyond our reach. Specifically, goals such as seeing how everything fits together should not be rejected, even if the possibility of their being attained is remote. We need to retain such utopian goals because they help guide our activity in situations that transcend individual aspirations. Examples of such goals are to be found in the sorts of programs human beings support even when they are not of particular relevance to their own discrete lives, such as welfare for the needy when one is affluent.

Sellars' conception of the goal of philosophy seems to be one of these utopian goals we should not abandon, even though we can never really complete our picture of how everything in the world hangs together. Philosophy, if it is truly concerned with understanding how to make our way around in the world, is necessarily and continually changing. As science tells us more and more, learning our way around that world must be an enterprise in constant need of updating, and so the philosophical questions we have been working on need constant rethinking. But to admit that no complete philosophy is possible is not to give up doing philosophy as a search for wisdom. In fact, philosophy remains alive and becomes increasingly important as the world becomes increasingly complex. The need to bring some degree of understanding to the apparent chaos of contemporary civilization becomes increasingly important as the world of human possibilities becomes more complex.

Central to my concerns is the disturbing tendency of the social critics and others to speak about "Technology" as if it were one thing. Try as I may, I cannot find the one thing. I can find automobiles, power stations, even specific government offices, but nowhere can I locate *Technology* pure and simple. It is the same problem I have when I try to find Science. I *can*

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1. The expression "life, the universe, and everything" is borrowed from Douglas Adams's book by that title, Volume Three of his five-volume *Hitchhiker's Guide to the Galaxy* trilogy, wherein the futility of comprehensive understanding is extolled. (The series was announced as a trilogy, and is still so labeled, but it has five volumes, indicating perhaps an extension of the author's philosophical position.)

locate physicists, biologists, journals, laboratories, etc. But I can't find the thing called "Science." And so, in this essay one of the themes, which I discuss in a number of different ways, is that there is no one single thing called "Technology." In this respect, the definition of "Technology" I offer—humanity at work—should be seen as punctuating the need to stop talking about *Technology* simpliciter and to start focusing on the specific problems we encounter and the techniques, materials, etc., we employ, as well as the consequences of using these techniques and materials to solve those problems. And while seeking to show how things hang together, I also work toward a conclusion that separates two concepts that currently appear to be wedded in our understanding of the world but should not be. These are the notions of "Science" and "Technology."

On the surface this sounds somewhat paradoxical. On the one hand, I am saying that in our complex world we need philosophical analyses to help us make sense of what we are doing. On the other hand, I am arguing that we should abandon, at least in this one area, efforts to oversimplify by talking about technology. How can we make sense of things by making the world more complex? The answer is that in a misdirected search for simplicity we end up misconstruing the actual situation, thereby opening ourselves to inappropriate actions. We should not confuse understanding with simplicity. The world is a very complex place, and we should not deceive ourselves into thinking otherwise, lest we suffer the consequences.

Finally, given the prevailing intellectual fad of hostility to anything concerned with establishing conceptual priority, something should be said about how it is possible in the current climate even to consider proposing a work on the foundations of the philosophy of technology. Recently it has been popular to dismiss the search for the intellectual foundations of inquiry.[2] Despite its popularity, it doesn't follow that that conclusion is warranted. The objection to claims about foundations comes from a slippery-slope argument, which acknowledges that our knowledge of the world is underdetermined by the evidence. Since scientific knowledge is said to be the foundation of all we know about the world, and since that knowledge is undermined by that underdetermination, science, it is concluded, is no better than any other form of inquiry. That is, whatever it is we come to know scientifically about the world, it is not enough to demonstrate conclusively that that is the way the world must be. Hence, it allegedly follows, science is just one form of inquiry among others, with

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2. Consider Michel Foucault and Jacques Derrida. In Foucault's *The Order of Things* (1966), he attempts to undermine the foundations of human sciences by exposing the contingencies upon which they rest. In the essay "Structure, Sign and Play in the Discourse of the Human Sciences" (1967), Derrida attempts to argue against the very possibility of a center or foundation.

no obvious claim to superiority. Thus, it is concluded, since science is supposed to be our most secure form of knowledge and since it cannot lay claim to absolute certainty, then there is no form of knowledge with sufficiently firm foundations to warrant claims of superiority to any other, and, so the argument continues, if science can't make the claim, then nothing else can either.

The fact that scientific knowledge is underdetermined by the evidence does not warrant the conclusion that no form of knowledge can be superior to any other. To my mind the best accounts of knowledge allow that knowledge is defeasible. What we know now may change in light of new discoveries. From this is does not follow that we know nothing now. Surely, to some extent, the resolution of this argument will be a function of how we define "knowledge." And I for one have a jaundiced view of efforts to find universal and eternal definitions of anything. For surely, whatever claims we make, whatever definitions we form, should be revisable in the light of continuing human experience. With that assumption in hand, I will opt for an operational, call it a pragmatic, approach to knowledge. This means that I will look for the hallmark of knowledge to be successful action. If, on the belief that x causes y, when I do x, y happens consistently, that is good enough for me. With appropriate refinements, this account should satisfy most skeptics as a working definition. That being the case, I think it fair to say that science is the most successful of human activities at producing reliable knowledge. It therefore has and ought to have a place of epistemic privilege, i.e., scientific knowledge ought to be preferred to other kinds of knowledge. And if that makes it foundational, so much the better.

Essentially I am suggesting that to seek for the foundations of intellectual inquiry is not necessarily to be committed to the belief that it is possible to find universal truths. Instead of true propositions, I wish to emphasize successful methods. It is in this sense that this work is a search for the foundation of the philosophy of technology. I am looking for the best methods to employ to understand both the varieties of technologies with which we are presented and the issues they present to us in a way that makes it possible to see how it all hangs together.

The structure of the book is fairly straightforward. First, I develop a framework for thinking about specific issues that arise in the context formed by a specific technology. Second, I introduce and explore a set of concepts that are counterparts to concepts that have already been the object of intense analysis by philosophers of science. The strategy here is straightforward. Philosophers of science have examined in detail a number of concepts integral to our understanding of what makes science what it is. If science and technology are as closely linked as assumed, there ought to counterparts to these concepts that apply to technology. Thus, following

up the concept of a scientific explanation, I look at the conditions for a technological explanation. It turns out that they are very different from the Standard View of scientific explanation. On the basis of a similar examination of several such counterpart concepts, I suggest that maybe science and technology ought not to be thought of as so closely linked in our thinking as we currently think they are. The bottom line is this: philosophical questions about technology are first and foremost questions about what we can know about a specific technology and its effects and in what that knowledge consists. This amounts to knowing what we as human beings can know about the world and our impact on it. That is why I think epistemological issues should be addressed before we engage in social criticism. I then proceed to attack a set of assumptions about "technology" put forth by social critics. Whatever else "it" may be, I argue that technology is not autonomous or a threat to democracy. I further argue that talking about technology in this way misleads in important ways. Finally, I address the problem of technological change. After examining extant models of scientific change, showing them to be inadequate, I explain the inadequacy by appeal to their failure to take into account the technological infrastructure of science and the manner in which science is embedded in and fundamentally tied to it.

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CHAPTER ONE

Looking for Definition: Epistemology and Technology

I WANT TO DISCUSS TECHNOLOGY in a such a manner as to allow those discussions to be informed by and, in turn to inform, the rest of our philosophical as well as our daily worries. It would help matters if there was a generally accepted definition of "technology." Many definitions exist, but there is little agreement on which one is the best. I propose, therefore, to start from scratch.

One way to begin is to distinguish between technology and other things with which it has been closely related. The activity with which technology has been most closely paired recently has been science. Unfortunately, most of what has been said in the abstract about the relation between science and technology has not been very helpful. In large part this is due to a series of assumptions about the nature of knowledge, in particular scientific knowledge. Science is a knowledge-producing enterprise. Much work in the philosophy of science has been epistemological, i.e., it has been concerned with the nature of scientific knowledge, its justification, structure, and relation to certain metaphysical issues. So, if a definition of technology is to be found by distinguishing technology from science, I suggest we look at the epistemological dimension of technology *in its own terms* and not as necessarily tied to science. To assume some crucial relation between science and technology begs the question.

Technology does have an important epistemological aspect to its character and, furthermore, as I have suggested, it is this epistemological dimension that is crucial to the philosophical placement of technology-related issues in the philosophical conversation. However, the standard account of epistemological issues has been formulated in such a way as to misdirect our approach to an understanding of the relation between science and technology. In particular, there are three mistaken assumptions about the epistemological relations between science and technology

that have governed much of our thinking about these matters. These assumptions are:

(1) a distinction between theoretical and applied knowledge, with science represented on the side of theoretical ("pure") knowledge;

(2) a hierarchical account of knowledge, with "pure" scientific knowledge presented as superior to applied knowledge;

(3) characterizing technology as applied knowledge, hence inferior to science.[1]

The first of these, the venerable distinction between "pure" and "applied" with respect to knowledge and science and technology, has it that science is pure and technology is applied. However, it is very difficult to determine what is supposed to be pure or applied in either area. If the proposed answer is "knowledge," then the claim becomes "science is pure knowledge and technology is applied knowledge," and this is surely false, since, as we shall see, science is not pure knowledge. Likewise, if technology is supposed to be applied scientific knowledge, this view must be rejected, for many technologies do not necessarily require prior grounding in the theoretical work of science.

Without trying to define "knowledge," we can, nevertheless, agree that the product of science is knowledge. To see this requires invoking (rather than attacking) a different distinction, this time between the *process* whereby we produce knowledge and the *product* of that process.

Science is a process composed of a large number of diverse activities undertaken by a variety of individuals in various settings, mostly in institutions such as universities and major laboratories established in governments or by business. If processes can be said to have goals, then our best way to understand the scientific process is normatively to characterize its goal as the production of knowledge. To accomplish this goal, scientists use theories, among other things such as instruments. Scientific theories consist of sets of assumptions about the population, structure, and behavior of a domain of physical entities whose existence is postulated in order to explain the behavior of objects we encounter or observe in everyday

1. This last assumption is such a popular claim that in some senses it is hard to document. It does form a background, however, to arguments about funding basic research, as well as providing the basis for distinguishing within science between different forms of activity by scientists, e.g., experimentalists versus theoretical physicists, field versus lab biologists, etc.

life. For example, the atomic theory of matter can be used to explain why some tables are hard while water at 50°F is not. Part of the process of scientific inquiry involves testing the assumptions of such theories, revising them in the light of new information, extending them into new domains, testing further, and attempting to find the limits to which these theories can be pushed before they have to be abandoned and replaced by new theories, new assumptions, etc. Because the scientific process *must* use theories to guide its research, the research is already infused with the assumptions of the theories and the methods being used to explore its domains. And when we change theories we do not escape assumptions; we simply replace one set of biases with another. So, in this very fundamental sense, science cannot be pure, for it is constrained and directed by its theories because the theories incorporate assumptions and preconceptions about the methods to use and the domains under investigation.

But there is another sense of "pure" that is relevant here. Science might be thought to be pure in the sense that its goal is "knowledge for its own sake." That is, the product of scientific inquiry is knowledge, but that knowledge is not the result of someone saying "we need to know *x*, so we can do *y*." When it is said that scientific knowledge is pure knowledge, or knowledge for its own sake, what is meant is that there is no reason for obtaining that knowledge *other than the goal of knowing itself*. This is often invoked as the justification for funding basic scientific research.

Unfortunately, this conception of science as the pursuit of knowledge for its own sake itself rests on some questionable assumptions. In fact there is a certain incompatibility between what we accept as knowledge and the idea of knowledge for its own sake. That incompatibility stems from the fact that the production of knowledge is, as we shall see, a community enterprise. The process/product distinction used above can also be of assistance here. But before we bring it into the picture we need to do a bit of history of philosophy.

The theory of knowledge has been an essential component of the philosophical landscape since philosophy became an important aspect of our culture. Enduring theories of knowledge date back to Plato and Aristotle. In the seventeenth century, with the rise of the New Science, answers to the philosophical questions about the nature of knowledge were attempted by individuals committed to the idea that science required a solid epistemological base. There were two major schools of thought at this point: empiricism and rationalism. Their champions included John Locke, George Berkeley, and David Hume for the empiricists, and Rene Descartes, Baruch Spinoza, and Gottfried Leibniz for the rationalists. There were significant differences between these two camps on a number

of issues, but common to both was an emphasis on the means whereby an *individual* acquired the basic material from which he formulated his beliefs and the process by which he transformed that material into knowledge. This total focus on the role of the individual embodied a crucial confusion between the process by which individuals acquired *beliefs* and the resultant production of *knowledge*. For instance, it was assumed that if the beliefs were acquired in a certain way, i.e., through experience, or if they could be traced to a certain kind of source, one that guaranteed certainty, then the content of the belief could be construed as knowledge. This view of knowledge is retained today by adherents of the view that knowledge is justified true belief. It is a view I wish to reject in favor of a more complex account in which the process by which individuals acquire and justify beliefs is but the first stage in the search for new discoveries.

There is no difficulty with the idea that individuals conduct inquiries, discover new things, and offer up candidates for inclusion into the body of accepted and integrated claims we recognize as knowledge. Let us refer to such claims as *candidate-claims*. Trouble begins when it is also assumed that the individual producing the candidate-claim is solely responsible for determining whether or not that candidate-claim counts as knowledge. To make this assumption is to take the path of traditional empiricist and rationalist epistemologies, with all their attendant difficulties. The way out of those difficulties is to make the *community* and not the individual the determiner of what counts as knowledge, that is, the ultimate status of a knowledge candidate-claim is determined by the community and not the individual. This approach is the result of the insight of the American philosopher Charles Saunders Peirce (1839–1914). It represents a major break with traditional epistemology and constitutes one of the key assumptions of the philosophical school of thought Peirce initiated that we know today as *pragmatism*.[2] It might be surprising to some to find out that this social component to knowledge comes from a thoroughgoing philosophical position and not from the less sophisticated views of contemporary thinkers committed to what has come to be called social constructivism.[3] Further, Peirce's view on the role of the community of observers is also

2. Although the philosophical stance of the author was not announced as "pragmatism," Peirce's 1868 essay, "Some Consequences of Four Incapacities" (CP: 5.264-317) outlines many of the concerns for this movement. Also see "The Fixation of Belief" (CP: 5.358-387) and "How to Make Our Ideas Clear" (CP: 5.388-410), esp. paragraphs 405 to 410 of the latter, for Peirce's account of the social character of science.

3. For examples see Collins 1981; Collins 1985; Collins 1990; Bijker et al. 1987.

tied to a deep-seated form of scientific realism, thereby avoiding a major critique of constructivism—its relativism. I do not share Peirce's realism, but I also reject the relativism of the Constructivists. In Chapter 8 I develop an approach that takes both the social component of knowledge and the methodological insights of realism seriously while rejecting Peirce's version of convergent realism.

Pragmatism also endorses the view that if the community is the arbiter of knowledge, then *successful action* is its criterion. That is, the ultimate test of what is to count as knowledge is determined by our ability to act successfully on that knowledge.[4] If the world is reported to be a certain way, the final test of that candidate-claim will be the success of an individual or a group acting as if the world were in fact that way. Not only is knowledge determined by the limits of action in this fashion; its purpose is action. Thus we seek to discover or uncover the way the world is in order to make our way around in it better.

It well may be the case that certain individuals involved in the process called science do whatever they do simply because of a certain innocent curiosity or because they derive personal delight from these activities. But we should not confuse the collective of activities called science with the personal delight of any one person. Whatever candidate-claims an individual proposes, it is the conclusions of the community of investigators that determines whether or not that candidate-claim is to count as knowledge at this time. That is one reason why publishing is so important in science. Publication amounts to community endorsement of those findings, i.e., candidate-claims. But the grounds for acceptance for publication have to do, for the most part, with how the candidate-claims fit in with what has already been accepted, where these already accepted claims have been shown to have real-world use, even if only in terms of offering explanations of the way the world works. It would seem, then, that if we reject the old-fashioned epistemologies of the traditional empiricists and rationalists, we must also reject the idea that it makes sense to talk about pure science producing knowledge for its own sake.

If we now turn to the other side of the coin and consider the idea that technology is merely applied science and, hence, applied knowledge, we don't fare much better. To begin with, there are technological items that have been constructed and used without a theoretical knowledge base to explain how they work. Consider the roads of Rome and Galileo's telescope. The Romans did not rely on "scientific" principles to guide the construction of their roads or aqueducts or catapults. When Galileo built his telescope there was no scientific explanation available to account for

4. This notion is first developed in "The Fixation of Belief," esp. CP: 5.384-387.