# Has the Philosophy of Technology Arrived? A State-of-the-Art Review*

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Using the occasion of the publication of a Blackwell anthology in the philosophy of technology, *Philosophy of Technology: The Technological Condition* (2003), as a key to the contemporary role of this subdiscipline, this article reviews the current state-of-this-art. Both philosophy of science and philosophy of technology are twentieth century inventions, but each has followed a somewhat different set of philosophical traditions and pursued sometimes divergent questions. Here the primary developments of recent philosophy of technology are examined with emphasis upon issues which might also be of greater interest to philosophers of science. These include epistemological, but also environmental and cultural issues. The bibliographical spread includes references to some fifty recent books in the field.

Blackwell Publishers, long recognized as a major publisher of philosophy, recently published another of its philosophy anthologies, *Philosophy of Technology: The Technological Condition,* edited by Robert C. Scharff and Val Dusek (2003). This anthology takes its place alongside previous volumes on metaphysics; epistemology; and analytic philosophy; or, if more appropriately one should list philosophy of technology alongside newer fields, then it takes its place alongside volumes in bioethics; minds, brains and computers; and environmental ethics.

I shall take this publication as one indicator of new arrival and will use some review comments as an opening for a selective overview of contemporary philosophy of technology. My overview will emphasize a guide to books, primarily since the mid-1980's, and I will largely restrict myself to English language and North American availability. In addition, I will focus upon aspects of the philosophy of technology which may be of greater interest to readers of this journal, that is, relations to science and the philosophy of science. (Much philosophy of technology relates to other

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areas of influence from technologies, such as issues related to the environment, social and political issues, and ethical issues.)

Both philosophy of science and philosophy of technology are largely twentieth century developments, with the former historically leading the latter by a few decades. The Philosophy of Science Association was formed in 1934, with much of its stimulus coming from just arrived-emigrants from Europe. Michael Friedman claims, "After 1933 the leading logical positivists emigrated to the English-speaking world . . . where they exerted a tremendous influence on the development of post-war 'analytic' philosophy . . . . Their influence, together with that of Carnap's protégé, Carl Hempel, . . . was decisive in establishing the new subdivision we now call 'philosophy of science.'" (1999, xii) The positivists, one might note, actually regarded philosophy of science as pretty much equivalent to all of philosophy, given their view of philosophy. And while philosophy of science today is much more heterogeneous, it retains many of the epistemological concerns of its earlier 'analytic' heritage. In contrast, philosophy of technology has primarily drawn its philosophers from the *praxis* traditions, in North America from pragmatism, phenomenology, and the neo-Marxian critical theorists, with analytic strands in a minority role.

Regarding the philosophy of technology, as recently as 1979, Mario Bunge, himself a major player, claimed, "[Philosophy of technology] is an underdeveloped branch of scholarship . . . suggested by the fact that so far no major philosopher has made his central concern or written an important monograph on it." (1979a, 68) Yet, that very year, two books were published which pointed to what would become differing perspectives upon how science itself could be interpreted. My *Technics and Praxis: A Philosophy of Technology* in the Boston Studies in the Philosophy of Science Series, came out, and, coincidentally, 1979 was also the year of publication of Bruno Latour and Steve Woolgar, *Laboratory Life: The Social Construction of Scientific Facts*. "Social constructionism" begins as well.

Granted, Bunge's view concerning philosophy of technology had been largely correct with respect to Anglophone areas of philosophy, but he had overlooked an older European development. Many of the major philosophers of this period, Ortega y Gassett, Karl Jaspers, Arnold Gehlen, Gunter Anders, and above all, Martin Heidegger, had written extensively upon technology by the mid-20$^{th}$ century. Bunge, echoing many then dominant sentiments within North American philosophy, simply dismissed European philosophy as 'ranting and raving'. Ironically, as I will show below, Bunge's take on technology and its relation to science, turns out to be nearly identical with Martin Heidegger's.

Interestingly, there is still no 'Philosophy of Technology Association', in part because the founders of today's Society for Philosophy *and* Technology (organized 1983), Carl Mitcham and Paul Durbin the most eminent, did not

like the idea of a new subdiscipline. However, Mitcham remains the primary 'historian' of the philosophy of technology. His *Thinking Through Technology: The Path between Engineering and Philosophy* (1994) is the most definitive such history to date. Durbin, too, has provided many summaries of the development of philosophy of technology in the two on-going series of the Society, *Research in Philosophy and Technology* (since 1978) and *Philosophy and Technology* (since 1980).

I now turn to the Scharff-Dusek volume as my launching point for comments upon the last decade-plus in philosophy of technology. The volume opens with a historical background with readings in Plato, Aristotle, Bacon, Marx, et al., pushing back philosophical interest upon *techne,* instruments, production, the arts and crafts to ancient and modern times. These are mostly good and appropriate texts—but the difficulty of such a search for origins is also indicative by its very selectivity to what could be called a sedimented *insensitivity to materiality* which I contend belongs to much history of philosophy. Theories, concepts, abstractions, propositions are the favored fields for exploration. Systematic treatment of technology is simply lacking until very recently.

History is followed by a section on Philosophy, Modern Science and Technology, with an opening sub-section on Postivitist and Postpositivist Philosophies of Science. In my opinion, this is the weakest and even quirkiest part of this volume. Rudolph Carnap, Carl Hempel and Stephen Toulmin as part of mid-twentieth century philosophy of science are prominently included, and are followed by representatives of newer challengers from feminism (Nancy Tuana, Sandra Harding), hermeneutics, and pragmatism (Patrick Heelan and Jay Schulkin) and Bruno Latour. As insightful as these authors may be, none of them would normally be classified as mainstream philosophers of science. What seems strange to me is the total absence of well known philosophers of science who could be called sensitive to science's materiality and material culture. Here the pioneer and primary cited philosopher would clearly be Ian Hacking, whose *Representing and Intervening* (1983), opened a long consideration concerning instruments (technologies) and experiments, and whose *The Social Construction of What?* (1999) brought these issues up to date. Isabelle Stenger's *The Invention of Modern Science* (2000), with her discussion of instrumentation beginning with Galileo and concluding with mathematics and computerization, and Robert Ackermann's earlier *Data, Instruments and Theory* (1985) could be mentioned, but above all the work of Peter Galison whose work is now monumental with *How Experiments End* (1987), *Image and Logic: A Material Culture of Microphysics* (1997), and his forthcoming *Einstein's Clocks, Poincare's Maps* (2003). Each of these philosophers explicitly produce a discourse sensitive to materiality and technology, but none are included in the Scharff-Dusek anthology.

While it is uncontroversial to note that science's technologies include instruments and experimental, laboratory equipment, and now, more broadly, it is acknowledged that science like any other technologically embedded activity has a material culture, what the role and relationship of technologies to science may be remains controversial. To employ a continuum for this issue, at one extreme one might place benign or malign neglect or lack of interest. Although Larry Lauden's *Science and Relativism* was published in 1990, I had not read it until the mid-90's, well after working through most philosophy of technology and the technology-sensitive philosophers of science mentioned above. Reading Lauden, in spite of his very contemporary sounding admissions of fallibilism, problem orientation, pragmatism, I felt thrown back into a time when philosophy of science still held an image of science as a propositionally oriented theory-machine, chastised but still theory and proposition biased. This pallid extreme leaves technologies outside science altogether, or else takes them for granted as simply transparent devices used in experiments. To take instruments either for granted or as simply transparent, is to make an implicit assumption that instruments are 'neutral' and this is a philosophical position concerning technologies and is thus open to debate.

A continuum which displays sensitivity to materiality thus would have to begin with some more positive and explicit evaluation of technologies vis-à-vis science. Mario Bunge, mentioned above and included in the Scharff-Dusek volume, is a good example. Bunge's view rather sharply distinguishes science from technology. Pure science, for Bunge, remains ethically neutral, culture-free, and objective, whereas technology, ''Far from being ethically neutral, like pure science, technology is involved with ethics and wavers between good and evil'' (1979b, 172). But, then in an interesting turn, Bunge also credits technology as being philosophically *productive*. Bunge sees that technological systems put ''forth a number of philosophically significant theories, such as automata theory,'' (1979b, 172) and, as the editors point out, the very title of his contribution hints at a technological model, ''Philosophical Inputs and Outputs of Technology'' (2003, 170). Overall, Bunge both differentiates between (pure) science and technology, but also between traditional and modern or pre-scientific and scientific technology, the later taken as *applied* science. Ultimately, for Bunge, (true) technologies are those derived *from* science, modern technologies. This latter distinction is virtually identical to Heidegger's view concerning modern technology. For Heidegger, science historically precedes modern technology, which, as for Bunge, is qualitatively different from pre-scientific technology. Heidegger, however, takes the interrelation between science and technology one step further than Bunge in that Heidegger holds that while modern technology is dependent upon

science, the reverse also holds and science is dependent upon modern technology (Heidegger [1954] 1993, 311–341).

Some degree of difference between science and technology is maintained by most 'analytically' oriented philosophers of technology. But the role of interdependence has become much more prominent since Bunge's early work. For example, Joseph Pitt's *Thinking about Technology: Foundations of the Philosophy of Technology* (2000), deals quite explicitly with the *technological infrastructure of science* which he relates to scientific change, often brought on or stimulated by improved instrumentation. His own work on Galileo's telescopes show that the role of a technological infrastructure belongs to the very beginnings of early modern science.

If a distinction between science and technology is one end of the continuum, the thorough blending or hybridization of science and technology, usually now termed *technoscience,* forms the other end. The two most prominent figures from what is usually called "science studies," Donna Haraway and Bruno Latour belong here—both are prominently included in Scharff-Dusek. Indeed, the volume is much better and more inclusive of feminist, postmodern, and both science studies and science, technology studies figures than of materially sensitive philosophers of science. In *Science in Action,* Latour claims that facts and artifacts or machines are effectively produced or constructed in the same ways (1987, 30). Haraway, under her earlier figure of the *cyborg,* sees technoscience as the full hybridization of science and technology. There are, of course, many others in the cognate disciplines who could be noted here: physicist turned sociologist, Andrew Pickering, would be one, his early *Constructing Quarks* (1984) has been superceded by his *The Mangle of Practice* (1995). In this later work, he criticizes social constructionism which he regards as, at best, good at analyzing social 'negotiations' between humans, but less good at the practice of science in 'negotiating' with materiality. And so should Steven Shapin and Simon Schaffer, *Leviathan and the Airpump: Hobbes, Boyle and the Experimental Life* (1985) be included, in which the three 'technologies' of instrument (air pump), writing style (third person anonymous) and modest witnesses (males only) constitute a new form of life. This book has been seminal for most technoscience thinkers and for producing a more robust image of science in practice.

But here I have been looking at near relations between philosophy of technology and the other sometimes materially sensitive disciplines such as the anthropology, sociology, and histories of science which now make up much of contemporary 'science studies'. I now return to a canon which would be considered more central to contemporary philosophy of technology as such. Sharff and Dusek include most of the recognizable forefathers; Jacques Ellul, Larry Hickman's Dewey, Marcuse, and Lewis

Mumford, who frequently also fills the role of forefather—but this volume clearly emphasizes Martin Heidegger with the entirety of Part IV containing Heidegger texts supplemented by Heidegger scholarship. (Scharff himself is such a scholar!) This emphasis might seem overstated, except that there has been so much within North American philosophy of technology which has and continues to relate to this tradition. The Indiana Series in the Philosophy of Technology, the first series with a philosophy of technology, subdisciplinary title, began its initial list in 1990 and included books on two of the primary forefathers of philosophy of technology, Michael Zimmerman's (1990) *Heidegger's Confrontation with Modernity: Technology, Politics, Art;* and Larry Hickman's (1990) *John Dewey's Pragmatic Technology*. Moreover, one can identify several of the leading North American philosophers of technology as remaining at the least 'neo-Heideggerian'.

Albert Borgmann perhaps remains the closest to this tradition and his trilogy, *Technology and the Character of Contemporary Life: A Philosophical Inquiry* (1984); *Crossing the Postmodern Divide* (1992); and *Holding on to Reality: The Nature of Information at the Turn of the Millennium* (1999) remains a major philosophy of technology corpus. Unlike Heidegger, however, his work contains specific analyses of a range of particular technologies. His early distinction between 'focal practices', which are technology-engaging activities, and a 'device paradigm', which are non-engaging technologies, has often already inspired secondary work, such as a full critical anthology concerning Borgmann, Higgs, et al. (eds.), *Technology and the Good Life?* (2000). Hubert Dreyfus, until recently probably not usually thought of as a philosopher of technology, has nevertheless through his long meditations upon computers, the internet and artificial intelligence, been 'baptised' into philosophy of technology anthologies. He, like Borgmann, retains many Heideggerian emphases. Others, while coming from strong Heideggerian backgrounds, have turned more critical, for example, Lorenzo Simpson's *Technology, Time and the Conversations of Modernity* (1995). Simpson parallels Heidegger with Habermas.

Also, highly visible in philosophy of technology circles, is the work of Andrew Feenberg. His earlier work includes scholarship on Marcuse, but he has also published a trilogy of books in the philosophy of technology: *Critical Theory of Technology* (1991, reissued and revised as *Transforming Technology* 2002), *Alternative Modernity: the Technical Turn in Philosophy and Social Theory* (1995) and *Questioning Technology* (1999), which sustains a critical relationship with Heidegger, although it re-situates this perspective primarily into a more social-political context within his version of critical theory. In Feenberg's case this perspective is widened to include sensitivity to multiculturalism, particularly from his experience with Japan.

Don Ihde's earliest book on philosophy of technology, *Technics and Praxis* (1979) was dedicated to Heidegger, but more recent works have increasingly turned critical, largely from dissatisfaction with Heidegger's romanticism, but even more with the inapplicability of Heideggerian analyses to the wider variety of different technologies. Increasing criticism occurs from *Technology and the Lifeworld* (1990), to *Expanding Hermeneutics: Visualism in Science* (1999).

Sometimes Heidegger—and with him, Ellul, Marcuse and even the later Mumford—have sometimes also been characterized as being 'anti-technology' or *dystopian*. And, it is certainly true that this set of forefathers did have a tendency to lump all technologies under a single, generalized or transcendentalized 'Technology', and to see such Technology as a danger or threat for humankind, (high) culture, or the future. For the later Heidegger, Technology (transcendentalized with the capital) was a certain way of seeing the world, wherein the whole of natural reality was taken as *Bestand* (usually translated as 'standing reserve' but maybe better thought of as a 'resource well' simply instrumental for human use). The one forefatherly exception is obviously John Dewey, whose instrumentalism did not take technologies to be negative, but useful. Larry Hickman has extended this view in his *Philosophical Tools for Technological Cuture* (2001). But recent European philosophers of technology have also recognized the earlier dystopian and transcendental tendencies. Hans Achterhuis, himself a major Dutch philosopher of technology, edited a book, *De Maat van de Techniek* [The Materiality of Technics] (1992) which included critical essays on Gunter Anders, Ellul, Arnold Gehlen, Heidegger, Hans Jonas, and Mumford, and one could recognize both general tendencies throughout this anthology. But, then, in 1997 Achterhuis, with five of his colleagues, published a follow-up called *Van stoommachine tot cyborg—denken over techniek in de niew wereld* [From steam engine to cyborg—thinking technology in the new world]. In the new edition, updated and ably translated by Robert Crease as *American Philosophy of Technology: The Empirical Turn* (2001), these Dutch philosophers turn to American philosophers of technology. They argue that the Americans are less dystopian than their European forebearers, do not transcendentalize technologies, are more 'empirical' in the sense that particular technologies are analyzed, and overall are more pragmatic—this set of tendencies, Achterhuis argues, has tended to replace those of the earlier generational views in contemporary philosophy of technology. The philosophers chosen as examples included Albert Borgmann, Hubert Dreyfus, Andrew Feenberg, Donna Haraway, Don Ihde and Langdon Winner—all are also included with representative sections in Scharff and Dusek.

Although I began this review article with some initial attention to science-technology relations, of interest to philosophers of science, much

philosophy of technology has not made these relations focal ones. If origins from different philosophical traditions is one major feature separating philosophy of science from philosophy of technology, then, a second major feature distinguishing these subdisciplines, has been precisely a difference in dominent problem sets. In the early North American decades of philosophy of technology, the dystopian fears that Technology might be 'autonomous', a runaway or historical determinant, often informed central problem areas and the Blackwell anthology includes a section on "Is technology autonomous?" Langdon Winner's early work, coming from Ellul and Marx as background, *Autonomous Technology: Technics-out-of-control as a Theme in Political Thought* (1977) elaborated upon this theme. His later, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (1986) anticipated the next set of problems for much philosophy of technology discussion. These included concerns with alternative and appropriate technologies. By the second decade of North American philosophy of technology, however, wider ecology and environmental issues—including technology transfer issues—began to be more prominent. These issues, too, are included in Scharff-Dusek. And the volume ends with a rich section on Technology and Social Practice, where the issues of politics, culture, and social change are forefronted. Many of these issues are also issues which are of wider, public interest and are doubtless one positive reason why philosophy of technology is beginning to be more widely recognized. Given its scope and size, despite certain lacunae, *Philosophy of Technology: The Technological Condition,* should serve as a useful and flexible source for courses in this subject.

I began this review of philosophy of technology by suggesting that a Blackwell anthology could be considered an index for some level of sub-disciplinary 'arrival'. In leaving Scharff-Dusek, however, I shall turn to two other indices which will show that in two usual 'academic' respects, philosophy of technology still has not yet quite 'arrived'. The first may be regarded as an internal indicator. Philosophy of technology has not, to date, generated recognizable and sustained internal arguments. For example, were one to draw from earlier Kuhnian language, a 'normal science' or discipline, is one which follows a 'paradigm' or has a recognizable set of issues and problems which it addresses. From such a perspective, philosophy of technology remains more 'pre-paradigmatic' than its family cousins, either the earlier arrived philosophy of science, or its chronological peer, science studies. While there have been issues amongst philosophers of technology, such as arguments about 'alternative or appropriate technologies', 'deep ecology', 'sustainable environmental practices', 'risk assessment', issues which provoke controversy, I have not detected anything like the several decade-long 'realism/anti-realism' debate which occupied so much of philosophy of science, with most principals engaged,

and on so many fronts. And, even if this set of arguments remained largely 'internalist'; its ultimate result a fragmentation of 'realism' into a very large variety of 'realisms', and perhaps not of much wider public interest, it did display a 'paradigmatic' quality for philosophy of science. Similarly, although the new sociologies of science are of the same age as philosophy of technology, these, too, have already developed paradigmatic debates. What is known as the 'chicken epistemology' debate between proponents of the largely UK 'social constructionists' (Steve Yearly, Harry Collins) and the largely French school of 'actor network theorists' (Michael Callon, Steve Woolgar, Bruno Latour), began in 1992 and continues sporadically to the present (Pickering 1992). This debate which revolves around methodology and 'symmetries', and is well known amongst 'science studies' participants and is in parallel with the realism/anti-realism debate in philosophy of science. It is also 'internalist' in the sense that it is not well recognized by wider publics, even those engaged in the wider public 'science wars' which tend to group all the new sociologies under 'social constructionism' as a term. Lacking any such identifiable debate, one could argue that philosophy of technology remains more 'pre-paradigmatic' than its cousins. I do not argue that this is good or bad, but it is indicative of a different 'sociology'.

In a second sense, one might consider external relations in which a distinct disciplinary approach must defend boundaries. While all three cousins are themselves less clear with respect to disciplinary boundaries and borders than many even older subdisciplines—I would hold that philosophies of science, philosophies of technology and science studies are all in degree necessarily *interdisciplinary* in practice and location. But philosophy of science and science studies have had to defend boundaries much more than has philosophy of technology. Regarding identities, in addition to simply having philosophers of science in a department—or having a bunch of them, much philosophy of science has been located within History and Philosophy of Science Programs (HPS), both in North America and the UK. Or, more recently, philosophy of science takes its place among a somewhat more diverse set of disciplines which now include history, but also sociology, anthropology, political theory, etc., within Science Studies Programs and Science, Technology and Society Programs, again both in North America and the UK. In both cases, the participant disciplines have identities and patterns of recognition which the other participants recognize. From this perspective, philosophy of technology has yet to arrive at all. While some philosophy departments include philosophy of technology amongst offerings, and there are recognizable philosophers of technology—only in a very few places more than one, there is still no strong philosophy of technology program at the graduate level known to me, nor is 'philosophy of technology' listed as one of the several distinct disciplines in most HPS or STS settings. Perhaps for

this reason, border wars—such as those which erupted between mainstream philosophy of science and the new sociologies of science during the 'science wars', have also not affected much philosophy of technology. Langdon Winner did take some potshots at social constructionism (samples included in Scharff-Dusek) and Albert Borgmann's *Crossing the Post-modern Divide* did the same for postmodernism.

Having spongy borders is not necessarily bad because when border wars are fought, if there are sharp boundaries it is sometimes possible to tell where shrinkages or expansions have occurred. One could argue that one factor in the arguments noted above revolves around 'who' will gain the right to intepret science, and over what will count as the 'image' of science. If that is an issue, then the older borders concerning what Bunge called 'pure' science have certainly suffered border violations in the decades since the rise of the new sociologies of science, and, I would hold that the emergent image of science may interestingly look a bit more, rather than less, to be a practice more like what he called 'technology', than its earlier pure mode as context-free science. But, while I would like to be able to claim that this change in the image of science was the result of a helpful counter-perspective from philosophy of technology, it was not. It was much more the result of the new social science studies of science, feminist critics, and a shift from a theory-oriented to a more practice and cultural-social interpetation fought out during the 'science wars', What I am here calling border conflicts are inter-disciplinary, more than intra-disciplinary contests. These latter conflicts do produce a larger, public interest. The 'science wars', led to the publication of a significant number of books, including *A House Built on Sand: Exposing Postmodernist Myths about Science* (1998) by Noretta Koertge. I will not draw any conclusions about the outcome, other than to indicate that the debate itself served to draw attention to what Ernan McMullen termed, in his volume of the same name, *The Social Dimensions of Science* (1992). If one admires the reasoned set of evaluations therein, then this, too, added to the changing of the image of science from its more abstract earlier form, to a more robust image which now includes social dimensions. There are also very few monographs which relate the disciplinary takes, but Helen Longino did address the sociology-philosophy of science debate in her *The Fate of Knowledge* (2001) and Don Ihde and Evan Selinger have recently published *Chasing Technoscience: Matrix for Materiality* (2003) which produces a dialogue between science studies principals and philosophy of technology.

If one considers the intra- and inter-disciplinary patterns, then one must conclude that as a subdiscipline, philosophy of technology is not yet parallel to its cousins. This may not be bad, since it means that there is also a lot of territory which can still be negotiated. I will conclude this overview by returning to some observations about philosophers and

technologies, and point to some non-realized areas of possible common interest, particularly some which relate to 'analytic', and could relate to the praxis, traditions. What follows is admittedly somewhat speculative and anecdotal, and I am drawing from my own reading experience, but hopefully informed readers will recognize the relevant features for development.

I observed above that there is little extant 'analytic' philosophy of technology and hinted that this is, in part, due to the double origins and problems traditions which currently characterize North American philosophy of technology. The dominance of the *praxis* traditions, plus the problem sets for philosophy of technology, which are situated more in the ethical-social-political arenas are divergent from the analytic and more dominantly epistemological concerns of most North American philosophers of science. But maybe this way of framing the differences is too extreme, so instead, I want to remark upon some interesting areas in which philosophers in the analytic traditions do deal with technologies.

One such group I have already noted—the small number of philosophers of science who have developed very sophisticated work on science's technologies (instruments and laboratory contexts), Hacking, Stengers, Ackermann, Galison as examples. I, in fact, earlier termed these ''instrumental realists'' in *Instrumental Realism: The Interface between Philosophy of Science and Philosophy of Technology* (1991), and compared their work to others from Continental traditions. The work of this strand of philosophy of science, perhaps not often explicitly noted for its kinship to philosophy of technology, is well known.

But there is a more implicit set of work whose origins trace back to philosophy of mind concerns which also confronts technologies—I refer to the thriving groups of *cognitive philosophers* now at work. To take one example: Andy Clark, *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence* (2003) examines a very wide range of prosthetic implants (cochlear, spinal, etc.) as well as human-technology interfaces (email, internet, and sensory devices), drawing interesting conclusions about the changes in human experience and consciousness therefrom. Clark does deal with many actual technologies, although he cannot refrain from speculative extrapolation. There is deeply embedded in much philosophical interest in technology associated with philosophy of mind, a distinct taste for *imagined technologies*. For example, Daniel Dennett's favorite versions of brains-in-vats, as well as many other of his imaginary technologies, or Derek Parfit's teleportation devices are prominent examples. The tradition of imagined technologies itself has a long history, drawing from Roger Bacon's thirteenth century imagined underwater vessels, flying machines, and the like, later made into visualizations by Leonardo da Vinci in the fifteenth century in his technical

drawings. I would like to suggest here that some negotiation between philosophers of technology (and historians of technology who would probably make this point even more strongly) might get into the act.

The popular power of imagined technologies derives, I suggest, from the now widely spread, but naive, belief that most imagined technologies eventually become actual. This is a sort of science-fiction myth—but historians and philosophers of technology are likely to be more skeptical and critical. Certainly, most imagined technologies *as imagined,* simply never become actual. For example, Leonardo's crude giant screw device imagined as a 'helicopter', even with high power motors to drive it, would never fly. Indeed, most historians of technology are aware that most of Leonardo's machines could not, in fact, work. Much more realistic would be a narrative something like Bruno Latour's account of the diesel engine, which in its ultimate actualization incorporated almost nothing of the designer's original concept—but it did eventually work (1987). I would go so far as to argue that merely imagined technologies are the utopian extreme balancing the imagined technological disasters envisioned by the dystopian forefathers who predict inevitable actual technological disasters: both are startlingly naive with respect to both technical and historical probabilities. But, my point here is that even imagined technologies constitute a field which ought to come within philosophy of technology concerns.

A second area of contemporary philosophical interest in technologies relates to the new machines for complexity, that is the whole range of computerization technologies. I have in mind contemporary work on modeling and simulation. One of the most interesting and simultaneously original programs is noted in Grim et al. (eds.), *The Philosophical Computer: Exploratory Essays in Philosophical Computer Modeling* (1998). In this work, initially applied to modelling semantic paradoxes, later to 'prisoner's dilemma' problems relevant for evolution, and recently to artificial social relations, technologies are incorporated into and used to do epistemology. Precisely because computer processes can perform data-image reversals, produce models for highly complex phenomena, and be tweaked for 'degrees of reality' (the more ambiguous, the more real, and thus also calling for new 'fuzzy logics'), technologies have begun to be of interest to areas of epistemology previously practiced abstractly and propositionally. Simulation and modeling constitutes another new and interesting field for philosophers interested in technologies.

I shall conclude with an example which shows that perhaps technologies have actually played a deeper and stronger role in philosophy than is usually thought. Philosophically, I contend, technologies have sometimes played major roles as metaphors, driving whole philosophical programs. Sometimes these metaphors are literalized into programs of metaphysical analysis and sometimes they produce what I have called, ''epistemology

engines." As an example of the first, Lynn White, Jr., one of the pre-eminent historians of technology, long ago pointed out that in the thirteenth century, just as mechanical clocks were spreading all over Europe, the clock became a technological metaphor for the universe itself.

> It is in the words of the great ecclesiastic and mathematician Nicholas Oresmus, who died in 1382 . . . that we first find the metaphor of the universe as a vast mechanical clock created and set by God to that "all the wheels move as harmoniously as possible." It was a notion with a future: eventually the metaphor became a metaphysics. (1971)

An example of the second, or epistemology engine metaphor, takes place at the beginning of early modern epistemology. Lee Bailey originally drew my attention to Descartes' and Locke's nearly simultaneous use of the *camera obscura* as the model for how we acquire knowledge itself, in his, "Skull's Darkroom: The *Camera Obscura* and Subjectivity" (1980). Drawing from a more ancient analogy between the *camera* and the eye, both Descartes and Locke extended the analogy to *camera*/eye/subject, thus placing the "I" inside the box of the *camera* and creating a theatre of the mind as Dennett recognizes. But also this technological epistemology engine produces most of the—to my mind antiquated—problems now belonging to the traditions of this metaphor. And while today a new 'engine' is rapidly being put into place through computerization and network metaphors, philosophers continue to draw resources from 'the technological'.

I conclude with a moral point: the areas of negotiation and of possible mutual interest call for something which rarely occurs between many individuals in the subdisciplinary fields, that is, it calls for everyone to read everyone else. In preparing this article, I did a superficial look at who cites whom (citations are evidence of reading; actual reading may not be evidenced) and the pattern which emerged was pretty dismal. But if philosophy of technology should be the subdiscipline which is most sensitive to materiality, then its practicioners should be leading the pack by reading the others who display this sensitivity—of course, it should go the other way, too.

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