Philosophy as Critique

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Abstract Philosophy of technology is a discipline that provides insights into the critical reflection on technology. There are two types of philosophical critique in that respect: an analysis of what we mean by technology and related terms like technological knowledge, technological design and technological literacy and an analysis of the way technology and culture interact. The first type of critique aims at providing a language and terminology for having a proper discussion on technology, and the second type deals with that discussion itself. In this chapter a survey of what has been developed in both types of reflections on technology is presented.

Keywords Analytical philosophy • Continental philosophy • Ontology of technology • Epistemology of technology • Ethics of technology

1 Introduction

1.1 Philosophy of Technology for Critiquing Technology

Philosophy of technology is relevant for technology education in several ways (De Vries 2005a). It can help to develop a sound conceptual framework for curricula and materials. It can also become part of the content of teaching about technology to provide students with material for reflection on the nature of technology as it relates to humans, nature and society. In this book, design and technology education as a means for making critical evaluations of technology is an important focus. Here, too, the philosophy of technology can be an important source of inspiration. Critical analysis of technology, both in terms of what we mean by it and the way it interacts with humans, nature and society, is at the very heart of this discipline. This chapter serves as an overture to the book in that it provides a survey of what philosophy of technology has to offer in that respect. I start by distinguishing two different ways in which philosophy does its critical work. Then I move on to show how each of

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these two modes of critique played out in the (short) course of history of philosophy of technology. I then briefly sketch what this means for design and technology education. But the real elaboration of this will be in the remaining chapters. I want to emphasise that for the sake of introducing philosophy as critique in a concise and accessible way, I will simplify the complexity of the philosophical approaches I will discuss. The reader should see this chapter primarily as an invitation to start (or continue) reading philosophy of technology and design literature and become more acquainted with all the nuances in the debates, more than can be presented in this chapter.

1.2 Two Types of Philosophical Critique

Philosophy is the systematic reflection on reality. This suggests that nothing can escape philosophy's attention. This is the case indeed. Perhaps this is what irritates people about philosophy. It does not seem to have any boundaries. Natural sciences are limited to studying natural phenomena that have a non-intentional character. Psychology is limited to studying humans and intentional phenomena. Linguistics study the way people develop and use languages, and in a similar way all scientific disciplines have their boundaries, within which scientists in that discipline are supposed to stay. This holds even though we encounter an increasing number of academic fields that deal with a variety of aspects of technology. For these, terms like multidisciplinary, interdisciplinary or transdisciplinary are used. But even for those, it holds that they do not have the breadth in scope that philosophy has. A field like environmental studies encompasses many aspects such as the physical, the chemical, the biological, the psychological, the social and the economical, but still it focuses on one particular topic, namely, the natural and technological environment of humans. For philosophers there seems to be no boundaries at all in terms of objects and phenomena that are studied. Another annoying aspect of philosophy is that it does not seem to have any concrete methods. A stereotype is that it is just 'reflection', without any specific indication of how this should be done. Is it just a matter of sitting and thinking? A third stumbling block for an appreciation of philosophy is that it does not seem to have a clear set of criteria for what can be said to be valid and reliable outcomes and what is merely a hypothesis, suggestion or speculation. What is scientific about philosophy? Or does anything go? Without proper answers to these questions, design, engineering and technology educators may feel well justified in regarding philosophy of design and technology as of little value.

There are, however, answers to these questions, although one may not like or agree with them. Let me start with the last two questions: yes, philosophy does have methods and, yes, there are criteria for judging what is scientific and what is not. The most important method in philosophy is argumentation. When I come up with a claim about what we mean when we say 'I know that screwdrivers are for driving screws', we have to defend this claim against objections. The claim might be: it means that I myself believe that screwdrivers are for driving screws and that I have found some sort of justification for that belief (e.g. I have seen most people using them for this purpose), and it is true. That seems quite reasonable. Someone, however, may object as follows: but what does it mean for this claim to be 'true'? Screwdrivers may well be used for other purposes. Can merely the name be sufficient for judging an improper use of the device? It functions very well for opening coconuts or tin can lids. For claims to 'knowledge', then more is needed than belief. We need some sort of agreement between all of us to allow one to claim to 'know' that this is a screwdriver. Philosophers who made the claim may come up with a next claim and say: 'Ok, I will adjust my definition to make it contain a social agreement about screwdrivers'. Then the opponent may come up with an argument against the new definition, and this goes on for as long as there is a disagreement about the definition of knowledge. This agreement will probably never be reached. That is what also annoys people: there seems to be no end to philosophical debates. That, however, is an unfair critique, as it holds for other humanities and sciences as well. When John Horgan's book *The End of Science* was published in 1996, immediately everyone started protesting: how can there be an end to the natural sciences? We have thought this many times, but always new phenomena were discovered that begged an explanation, and often these phenomena posed a challenge to existing explanations for other, already known phenomena. So why should philosophical inquiry have an end? Besides that, philosophical inquiry does not turn in circles ad infinitum, as people may think. In past centuries of philosophical exploration, we made progress in our effort to define what we mean by the claim 'I know that . . . '. We still may not have found a watertight definition, but we do know a lot about where definitions can lead. Other methods used in philosophy are dialectics (present the solution and arguments for criticism by other philosophers, and help them judge their own) and hermeneutics (a set of normatively binding rules by means of which the process of interpretation should proceed; it is good to note that the term also has a wider meaning in which it serves as 'an interrogation into the deepest conditions for symbolic interaction and culture in general' as the Stanford Encyclopedia of Philosophy phrases it). These last-mentioned methods are necessary to include as they take away the idea that philosophy is all about providing watertight definitions and conceptualisations. Philosophy is also, and perhaps primarily, more about raising doubts (sometimes 'systematic doubt' is even seen as the primary method in philosophy) and questions than providing answers.

What remains the case is that philosophy has no boundaries when it comes to objects of study. That does not mean that philosophy is an unstructured and fuzzy field of reflections. There are some sub-disciplines that do have a sharp focus (Morris 1999). The example above features epistemology, a sub-discipline of philosophy that aims at defining what we mean by 'knowledge', what types of knowledge can be distinguished and how they differ from each other. For design, engineering and technology educators, this can get exciting when we ask what makes technological knowledge different from natural science knowledge. Often it is said that design and technology is not a knowledge domain of its own right, but merely ‘applies’ knowledge from natural sciences. What if philosophers have shown that this is incorrect and there are features and examples of technological knowledge that clearly cannot have been derived from natural sciences? Ontology deals with different ways in which things can ‘exist’. ‘Things’ should then be taken broadly to encompass not only objects but also events. But events exist in a different way than objects. I cannot touch my birthday as I can touch the birthday cake. Yet, my birthday can be said to exist, no less than the birthday cake. For design, engineering and technology educators, this seemingly vague and abstract question may become more interesting when we ask if perhaps technical artefacts ‘exist’ in a different way than ‘natural objects’. Metaphysics concerns world views. ‘Beyond physics’ is the literal meaning, and it indicates that physics only deals with what can be observed, but that there is more than this. We all hold beliefs about the nature of reality. We have, for instance, beliefs about the mind: is it just a side effect of matter or is it something that may be related to matter, but also has non-material properties? A sub-discipline is the philosophy of mind and it becomes a matter of interest for design, engineering and technology education when it is used to reflect on the nature of computers and in general, artificial intelligence (AI). AI makes us wonder about ourselves: are we just sophisticated computers, because all this talk about mind and soul is just metaphorical, or do we differ fundamentally from those devices because we have something that they do not have, in spite of the fact that the likeliness between them and us becomes more and more impressive. Finally, there is the domain of ethics, probably the only one in which people intuitively see some usefulness. Ethics includes moral philosophy and questions of morality: what do we believe is morally proper and what is not? What do we mean, anyway, by ‘morally proper’? Obviously, this is a sub-discipline in philosophy that design, engineering and technology educators often find themselves interested in, although at the same time they often hesitate to bring it into classrooms for fear of being accused of indoctrination. This fear illustrates a fundamental misunderstanding about what ethics is. And that, in turn, illustrates that our scepticism about philosophy is often related to a lack of knowledge of what it really is. Another value-related sub-discipline of philosophy is aesthetics, which obviously is also quite relevant to technology. The term ‘axiology’ is often used, either as an umbrella term for ethics and aesthetics or to indicate the search for principles underlying both.

Philosophy can also limit itself by focusing on a specific domain of human activities. Thus, we have philosophy of science, philosophy of religion, philosophy of law and philosophy of design, engineering and technology. Each of these may cover questions similar to the ones we identified when discussing epistemology, ontology, metaphysics and ethics, but deals with them in a specific way. To use the term ‘applying’ them is a bit dangerous here, too, because sometimes, discussions in these specific domains give rise to new questions in the general sub-disciplines. Epistemology of technology, for instance, has shown that the traditional approaches of trying to repair the ‘justified true belief’ account of knowledge (that was also the basis of my example) does not address fundamental features of technological knowledge such as its normative dimension (later I will return to this).

In this chapter I want to show that philosophy is a fundamental way of critiquing reality (including design, engineering, technology and everything related). The strength of philosophical critique is that it is based on philosophy's primary method, namely: argumentation. It is not just buckshot scattering various ideas and questions, but a well-founded form of critique that cannot be dismissed by shrugging shoulders. Philosophy can be used as critique in two distinct ways, each of which has led to a certain tradition in philosophy (Verkerk et al. 2015). These are indicated by the terms continental philosophy and analytical philosophy. Immediately it is clear that these are non-philosophical terms, as they are incomparable. Continental is a geography-related term and indicates that philosophers in this tradition generally live(d) and work(ed) on the European Continent. Analytical indicates a way of thinking. It is conceivable that people thinking analytically live and work on the continent, as well as in other places. So the terms are in fact inappropriate for dividing all philosophers into two separate groups. That is why nowadays the terms are often abandoned, although a good alternative has not yet been found. But whatever the names, two distinct ways of critiquing can be identified.

The first critique refers to what so-called analytical philosophers do: they analyse terminology. This is often seen as the more 'exact' part of philosophy, where argumentation plays the most vital role. My example from epistemology derives from that realm. Before starting a discussion of dangers or advantages of having knowledge of some socially sensitive issue, we have to agree on what we mean by knowledge to prevent complete chaos in the debate. We may think that our conventional, daily-life use of terms suffices, but that is often an overestimation of our intuitive analytical capabilities. We do have a lot of inconsistencies in the way we use terms, but this often goes unnoticed. Let us take the debate about technology: is it applied science or is it not? Some people say 'Yes'. They come up with examples such as transistors, lasers and the atomic bomb and show how much these were the result of research in physical sciences. Others, though, say 'No' and come up with the steam engine, glass lenses and early airplanes and show that their inventors had hardly any solid knowledge of the natural phenomena on which their inventions were based. For the philosophy of design, engineering and technology, the analytical approach in philosophy leads to questions like: what do we mean by 'design', by 'technology', by 'engineering', by 'technical artefacts', by 'technological knowledge', by 'requirement', by 'optimisation', etc.? Is design a knowledge-producing or knowledge-using process? That depends on our answers to these questions. So first we have to agree on what we want them to mean (a matter of choice indeed!) and only then we can have a philosophical discussion.

The second type of critique for which philosophy can be used is related to debate itself. This is what people will intuitively associate with the term 'philosophy': dealing with the big questions 'Why are we on earth, why do we love or hate each other, why do we feel the need for developing knowledge and why do we have technology? Or why should we, perhaps, sometimes not have technology or have it only in certain ways or under certain conditions? Let us call this, for lack of a better alternative, the human/social approach in philosophy.

The analytical and the human/social approach clearly need each other. For a proper debate, proper terminology is needed. Vice versa, a proper terminology is useless without a debate in which this terminology is used. In design, engineering and technology education, too, we need both forms of critique. Our terminology needs critiquing because we want to teach students proper terminology, and we first need to be consistent ourselves. The ideas that have been developed in the analytical (sometimes called the Anglo-Saxon) tradition can be valuable. Also we want to make students aware of social debates related to technological developments, and for this the ideas that have been developed in the continental tradition can be useful. As philosophy always tries to go to the very basics in critiquing and characterising, this also makes philosophy relevant for education. In education we want to start simple and only then move on to the complexities. If, for instance, we want to teach about all sorts of technical devices, it makes sense first to start by showing what the basic characteristics of any technical artefact are. The philosophy of design, engineering and technology has developed ideas about that (I will come back to those later); these insights can help to start simple and only then move on to details.

1.3 The Early History of Philosophy of Design, Engineering and Technology

It is remarkable how late the philosophy of technology emerged in the field of philosophy. Given the importance of technology in society and its impact on human life, one would expect that this would be one of the first phenomena to arouse the interest of philosophers, but it was not. Philosophical reflection on science preceded reflection on design, engineering and technology, although it is not hard to show that technology is older than science and has at least as much influence on the way we think and live. Perhaps it was the strong association with material reality that held back philosophers from developing a systematic reflection on design, engineering and technology (or designers, engineers and technologists systematically reflecting on their discipline). Philosophers were perhaps so much focused on the mind and so much less on matter that they did not mind about matter. In other words: matter did not matter so much to them. Whatever the reason may have been, the philosophy of technology is probably not older than approximately 50 years or so. Following interest in mechanical philosophy, one of the first publications with ‘philosophy of technology’ in the title was *Philosophie der Technik* by Ernst Kapp, published in 1877 (Mitcham 1994). But for a long time, this book remained a stray stone. Perhaps the first publication that can be called a philosophy of technology after Kapp’s book was the essay *Die Frage nach der Technik* (The Question Concerning Technology) by the German philosopher Martin Heidegger in 1954. In these two publications, we can already recognise the difference between the analytical and the continental approach. Kapp’s intention was to identify the nature of technology. Accordingly, technology was a human projection of body organs. A biface is a projection of our fist, made because our fist is not strong enough to split stones. Pots and pans are projections of our hands, made because we each have only two and yet need to hold a lot of food and liquids in a household. Glass lenses are a projection of the lens in our eye, made because it does not produce a sharp image. And so on. It was much later that this origin of the philosophy of technology was picked up again in the extended mind idea, developed by Andy Clark and David Chalmers in their 1998 article with the same name: the idea that notepads, electronic memories and the like are in fact extensions of our human mind that make the boundary between mind and matter become fuzzy. So Kapp's early work in the philosophy of technology was primarily analytical. His way of critiquing technology was by revealing its basic intentions: to extend the human body. Heidegger's work, on the contrary, should be seen in the human/social realm. The idea developed in his essay was that technology has taught humans an instrumentalist way of looking at reality. We hardly enjoy anymore the beauty of a tree; rather, the first thought that comes into our minds is: how many planks can I make out of that tree? He called this the 'Gestell' of technology, a sort of framing in our minds. In *Die Technik und die Kehre* (The Turn) (1949/1962), he continues this critique by claiming that technology forces nature to provide resources for humans. Still today, this view of technology seems to be popular, and this was stimulated particularly, of course, since we became aware of how much we have 'tortured' nature so that it has become seriously distorted. Different as they are, both Kapp's and Heidegger's approaches have relevance for today.

For a period of time, not much was done in the analytical realm. Perhaps the two most noticeable exceptions are the French philosopher Gilbert Simondon (see Ginestié in this volume) and the Dutch philosopher Hendrik van Riessen. Simondon worked on the meaning of the term 'technical object' (we would nowadays say 'technical artefact'; De Vries 2008, 2010). According to him, what we mean by that is not just the tangible object as it stands before us, but also the whole line of development in which it stands. The object is also a process of becoming, or as Simondon calls it, the 'individuation' of the device. He uses the same term for humans, and it should be read in the context of an evolutionary perspective. In this process, the artefact more and more integrates different functions, and this is what Simondon calls 'concretisation'. Simondon did not have an engineering education, but he had carefully investigated numerous devices in their technical details. This, too, made his book *Du mode d'existence des objets techniques* (1958) an exception in the philosophy of design, engineering and technology of that time. Van Riessen also focused on the nature of technical artefacts and saw them as entities that functioned in different aspects of reality: a bridge, for instance, is not just a physical thing (obeying the conditions set by the laws of the physical aspect of reality) but also a spatial thing, an economical thing, an aesthetic thing and even a 'trust' thing (referring to an aspect of reality that entails that all things can be the subject or the object of trust). Both Simondon and van Riessen used their analyses to show that there is nothing inhuman about technology, but that rather technology is an integral part of our human existence. This illustrates that the analytical approach, generally speaking, was more positive about technology than the continental approach. The critique of technology in the analytical approach was primarily focused on making us aware how rich the existence of technical artefacts is: it is not just a single object, but stands as a constellation in a long line of development and functions in many different aspects of reality and therefore can be studied from many different points of view.

1.4 The Continental Approach

As stated before, Kapp, Simondon and van Riessen for a long time were exceptions in that they represented the analytical approach, whereas most philosophers of technology in the second half of the twentieth century took the continental road. It was not until the end of the twentieth century that the interest for the analytical approach was revived. Unfortunately, the continental approach was largely negative about technology, as we already saw with Heidegger. Another philosopher who wrote about technology in a very gloomy mood was Jacques Ellul. His view of technology was that it had become almost entirely autonomous (Ellul 1990). As it played such an important role in culture and society, it was a system with endless feedback. We did not choose computerisation and atomisation, they just overtook us.

The exceptions to the rule that continental philosophers were very critical of technology were Karl Marx and Friedrich Engels. They held a deterministic view of history inspired by another German philosopher, Georg Hegel, and believed that the disappearance of capitalism and the liberation of the labour class would come as an historical necessity and technology would be the lever to cause that. It was the labouring class in particular that had technology in their hands because they were the ones that were responsible for the production of goods. This would enable them to overthrow the dominance of the capitalists. For that reason, Marx and Engels were very positive about the role of technology in society. This is also why communist countries had a high respect for technology education. In the former Eastern European countries, 'polytechnic' education, as it was often called, had a prominent place in the curriculum, long before other Western countries had it as a compulsory subject. An excellent conceptual development for technology was done in the context of polytechnic education, among others by Dietrich Blandow (1992). Unfortunately much of that got lost when polytechnic education was abandoned almost immediately after the breakdown of the communist system in the late 1980s.

Both the existentialist and the neo-Marxist approach were continued after the death of their respective founding fathers. Still today they form two major forms of critique concerning the position of technology in human lives, nature, society and culture. Perhaps the most prominent current philosopher of technology who writes in the traces of Heidegger is Albert Borgmann, an American (note how inappropriate the term continental philosophy is). In line with Heidegger, he criticises technology for having caused a situation in which we are entirely focused on commodities that are provided by the devices that surround us. We forget to ask the basic question of the purpose of these devices. Why do we want these commodities? Is there no deeper purpose of life? Those are the sort of questions that Borgmann poses. His term for the role of devices as purely providing for commodities is the ‘device paradigm’ (Borgmann 1984). Accordingly, our personal experience of reality has become much poorer than before because of this paradigm. In the past, when we wanted to bring our home to a comfortable temperature, we went into the forest, cut wood for our stove, brought it home with great effort, and then made a fire, which often was also quite a challenge. Now we just programme the thermostat a bit and up goes the temperature. Not a very rich experiencing of reality, according to Borgmann. Our experience is poorer also in the sense that the device paradigm makes many experiences uniform. This is necessary to make the commodity affordable in terms of economies of scale. We make a meal by putting a ready-to-eat meal in the microwave oven, push a few buttons and after a couple of minutes we take out the meal and eat it. It tastes exactly the same each time we use it. Compare that with the cooking of a meal from basic ingredients: a bit of this and a bit of that and each time a bit different. Isn’t there much more pride and satisfaction in the meal that is prepared that way than in the case of the microwave bite? What is the proper treatment for this diagnosis? This is what Borgmann calls ‘focal activities’: activities that focus our attention on reality so that we get a more intense and rich experience. For instance: go by bike instead of by car, cook your own meal, attend concerts or play an instrument instead of listening to ‘canned’ CD or mp3 music, etc. Borgmann realises that we have already gone too far to make this the basis for our lives, but he makes a plea for at least giving it some room in our routines, so that we still feel the difference between those rich experiences and what the device paradigm offers.

Also in Heidegger’s vein, but more balanced in his critique, is Don Ihde. He calls himself a post-phenomenologist to indicate that he takes a step further in the line of the phenomenologists, which is closely related to the existentialist line. His particular interest is the way in which technology intervenes in our experience of reality. We seldom ‘see’ reality directly, but mostly via technological instruments. Ihde distinguishes different modes in which this happens (Ihde 1990). One he calls the hermeneutic relation. Here the awareness of the role of technology is most certainly important. A domain that Ihde often uses to illustrate this is that of medical imaging. What we see is an image that represents a reality ‘behind’ it. The MRI scan picture represents a body, but in a way that needs interpretation (hence the term ‘hermeneutic’). It is even the case that one and the same scan can be represented in different ways, depending on the need of the doctor (the oncologist gets a different image of the same scan than the neurologist). An example where we confuse things if we do not realise this role of technology is when we admire an image of the stars produced by the Hubble telescope. We see many colours and mistakenly think that stars have different colours, while actually the colours in the image represent temperatures. Overlooking the hermeneutic relation in that case leads to misunderstandings. That can also happen in the case of the other mode, the ‘alterity relation’. In that case, we see a reality that is created by the technology itself. The most obvious example is games, including multi-user games like Second

Life and other virtual worlds. We can create our own avatar and observe that world, but what we see is not 'real'. As long we are aware of the alterity role of technology, that is not a problem, but when we confuse virtual reality and 'real' reality (oops, how confusing can it get!), then we make a mistake. The more advanced the games and virtual worlds become, the more they look like the real world and the easier the confusion emerges.

We have seen how the existentialist and post-phenomenologist approach critique technology: by pointing out how technology can take our attention away from the richness of reality and the deeper questions of life by providing us means for simple (but uniform) commodities and how technologies create our images of technology, which can be enriching as long as we recognise the role of technology. This becomes misleading when we overlook this role. Let us now see how the neo-Marxist line has also continued after its founding fathers had died.

The most prominent here is Andrew Feenberg. His primary concern is the role of technology not only in the lives of individuals but in society as a whole. He takes up a point that Herbert Marcuse brought forward, namely, that the rationality that reigns in technology is a choice, not a necessity. People may think that there is one optimal solution to any socio-technological problem, but what is optimal depends on one's rationality. The rationality that determines current technological development is mostly that of capitalism and economic growth. Feenberg challenges that rationality and shows that it is well possible to open up this rationality and allow for other rationalities to 'hack' technologies and use them for different goals. His empirical evidence for that is the Minitel system in France. Originally designed for dissemination of government information in libraries and shopping malls, hackers literally hacked the system and started using it for exchanging information (Feenberg 1999). Feenberg applauds this and developed a view of technological developments in which there is an explicit place for this democratisation of technology. He writes about primary and secondary instrumentalisation. In primary instrumentalisation a socio-technological problem is decontextualised so that engineers can design a solution to this problem. In secondary instrumentalisation, the solution is recontextualised, and in Feenberg's view, this is not just a matter of passively accepting what the engineers have come up with, but actively adapting it to the needs of (specific groups in) society. Thus, technology can become a vehicle by which all social classes can have a say in the way technology is used in society. This would then be an alternative for technologies being used to consolidate the power of the ruling class. Feenberg's secondary instrumentalisation would find ways of turning that upside down and adapting the bridges and parkways to make them play a totally different role. In a way Feenberg resembles Ihde in that he continues a line of continental philosophy of technology, but turns the rather gloomy image of technology into one in which technology can also be seen in a more positive light. Information technology is perhaps the most prominent example that shows how technology can be a means for democratisation. At the same time, Winner would argue that it can be a means for controlling society and economy and raises important questions concerning privacy and reductionist tendencies by treating people as 'data' (Winner 1986).

Another philosophy, neither really analytical nor really continental, in which technology was appreciated in a positive way is pragmatism. As with the next approach that will be mentioned here, the religion-inspired one, pragmatism, is discussed in a section on continental philosophy although it does not fit there quite naturally. Pragmatism emerged mainly in the USA, which is clearly not continental ('continent' meaning the European continent). On the other hand, pragmatism is not primarily concerned with conceptualising, as in analytical philosophy. What pragmatism has in common with what is called continental philosophy in this chapter is that it provides answers to very basic questions about what life is about. That communality seems to be more important than the geographical mismatch with the name 'continental philosophy'. As it is very common in philosophical literature to use only two basic categories in surveys of philosophical 'schools', in this chapter I stick to the continental versus analytical dichotomy and put pragmatism and religion-inspired approaches under continental. In the philosophy of technology, Larry Hickman is a well-known representative of pragmatism. Hickman follows the traces of John Dewey whose conviction was that no a priori values should determine our decisions, but we should always try out different options and see what works. Hickman sees engineers as the best examples for how to do that. Engineers develop prototypes and test them, and eventually practice determines what is the best solution (Hickman 2001). What works is good. Or in pragmatic epistemology, what works is true. Education was seen already by Dewey as the context in which we should learn this way of thinking by doing. Education is not the transfer of a priori truths, but the development of insights by trying out what works and what does not. Thus, in pragmatism technology becomes the model for all social decision making. By all means, a positive critique.

There are also philosophers of technology who have religion as a starting point. These, too, do not sit comfortably in the continental 'stream'; as among these, we also find philosophers that are definitely analytical (the epistemologist Alvin Plantinga being a well-known example). In this section the focus will be, however, on those religion-inspired approaches that are continental in the sense that they are not primarily involved in conceptualising but in answering basic questions of life. One of such 'schools' is the 'reformational philosophy', inspired primarily by the Dutch philosopher Herman Dooyeweerd, who also developed a view on technology. In this view, technology is put into a double perspective. On the one hand, technology is seen as a God-given opportunity to work in His creation, and at the same time it is done by humans who also have evil tendencies and may use their technological capacities for greedy and selfish purposes, thereby neglecting the intrinsic value of God's creation and creatures (Schuurman 1997). A similar view is often held by Islamic philosophers of technology, but they do not recognise an original 'paradise' state in which humans were not yet fallen in sin. Both Christian and Islamic philosophers of technology expect the end of history to come when God intervenes and brings (again) a state of perfection (Jochemsen and Van der Stoep 2010). Here, too, is a difference between a Christian and an Islamic perspective in that in Islam the place of humans in this new state is decided purely on the basis of their own acts, while in Christianity the notion of sins being forgiven is crucial for determining whether someone ends up in the new paradise or in hell. I mention this religion-inspired notion of paradise because it plays an important and often overlooked role in current technological developments, particularly in the rhetoric that accompanies it (Noble 1999).

In this context, the notion of utopia should be mentioned. A utopia (literally a non-place, to indicate that it does not really exist) is a place where everything is perfect and ideal. We see this particularly in the promises that accompany nanotechnology. It is claimed that this technology is so fundamental because one day it will allow us to manipulate individual atoms; hence, we can make everything we want and also exactly the way we want it to be (De Vries 2005b; Peterson and De Vries 2012). That includes biological 'devices'. There is a discipline of 'synthetic biology', but it has not yet perfected the manipulation of individual atoms (rather biologists work with larger 'chunks' of living matter). But it promises that one day we will be able to build life, and then build perfect life, without vulnerability to disease and death. We see a similar promise in virtual worlds: in such worlds all sorts of boundaries in reality are non-existent. In a virtual world we can create ourselves as an avatar that can have any shape we want ourselves to have. The 'no boundaries' ideal can also be found in advertisements. 'Endless fun', 'endless shrimp', 'unlimited broadband' and 'unlimited data' show the ideal of doing away with all limitations that we see as barriers to perfect happiness. Religion-inspired philosophy critiques these types of promises by pointing out that we humans cannot and should not bring about this state of perfection. Although, we do have a duty to seek to try to improve the world in which we live. It is not only religion-inspired philosophers that warn against this utopian thinking in technology. Dutch philosopher Hans Achterhuis points out the main danger of utopian thinking: at a certain stage we are willing to pay any price to get to the utopia realised (De Vries 2012).

In summary, the continental critique of technology was mostly critical, particularly in the early years. Technology was blamed for gaining autonomy and control, for depriving us from a feeling of freedom, from taking away attention from the important questions in life, and for creating a distorted or confused view of reality. Later the picture became more balanced, not just negative. Technology was acknowledged also to be a means for enriching our view of reality and for changing or democratising society.

1.5 The Analytical Approach

We will be shorter about the analytical approach as much less has been written in this realm than in the continental approach. As we have seen, the analytical approach was perhaps the beginning of the philosophy of design and technology, but for a long time remained the exception rather than the rule. It was not until the 1980s that the analytical approach became more popular. It was a different type of philosopher who became interested in the analytical approach. Usually, continental philosophers are *philosophes 'pur sang'*: they have a philosophical background only. Those who became interested in the analytical approach in the philosophy of design, engineering and technology usually had both a philosophical and an engineering (or natural or physical science) background. Perhaps it was annoyance about the naivety with which continental philosophers often wrote about technology, a naivety that revealed their lack of internal understanding of technology and engineering that renewed analytical philosophy's reflection on technology. Whatever may have been the real motive, the fact is that these analytical philosophers started not by writing in very general and abstract terms about technology, but by examining empirical studies made by historians and sociologists and also by examining literature from within the engineering profession. This was sometimes called the 'empirical turn' in the philosophy of design, engineering and technology (Kroes and Meijers 2000), and it mirrored a similar turn in the philosophy of science (created by such philosophers as Bruno Latour, John Law, Michel Callon and others).

The analytical approach critiques technology in a different way than the continental approach. The latter is more concerned with how technology has an impact on individuals and society. The analytical approach deals with critique of our understanding of technology itself, of our understanding of the nature of technology. Three domains were particularly seen as interesting: the ontology of technical artefacts, the epistemology of technology and engineering sciences and the methodology of design. Let us take a closer look at each of those and see how they critique naïve understandings of design, engineering and technology.

Artefacts play an important role in our intuitive notion of technology. But what makes an artefact an artefact? Our first hunch is of course: it has been made by humans. That distinguishes it from natural objects like beehives, beaver dams or stones and trees. But it is not always easy to tell whether an object is human-made or natural. Can you tell the difference between a flower that grew without any human intervention and one that was cultivated in a greenhouse? And does it matter anyway when you want the flower to bring some beauty into your house? Is the origin enough to make the distinction between a natural object and a technical artefact? In the analytical philosophy of technology, the idea has been developed that what makes technical artefacts distinct from natural objects is that they have a relational nature, apart from the physical nature that natural objects also have. The stone in the woods that no one notices has a physical nature (it can be described in terms of its shape, weight, colour, etc.). But the screwdriver I use has more than that. It is a screwdriver because we as humans regard it to be an object with which we can drive a screw. Even stronger: we may also decide to regard it is a means for opening tin cans. Evidently the physical nature is intrinsic, and it is not up to us to decide what its weight, colour, etc. is. But for the screwdriver to be a screwdriver, it takes a human to decide that it is a screwdriver (or a paperweight, a can opener, etc.). This relational nature of technical artefacts is something that we easily overlook, which makes us think that artefacts can only do what they are designed for. That stimulates a deterministic view of technology. The dual nature view liberates us from a deterministic view of technology (or at least provides an important underpinning for a nondeterministic view).

In the epistemology of technology, a main focus has been to show that technology is not just applied science, as has been suggested since the 1950s. This, too, is a critique of conventional ideas about technology that may hamper us to develop a view of technology in which things are not just as they are, but are a matter of decision making. The applied science approach suggests that scientific knowledge can be translated into products in a deductive way (because it suggests that no new knowledge is developed in the process). This again suggests determinism in technological developments. But in the philosophy of technology, we have become aware that most technological knowledge cannot be derived from science, and this is the normative dimension (De Vries et al. 2013). Engineers have knowledge of functions. But function does not tell us what the artefact does. It does not describe the behaviour of the artefact. It rather tells us what the artefact should enable us to do. The screwdriver is a screwdriver not because it actually drives screws, but because I want it to drive screws. If it does so, and it does it well, I call it a 'good' screwdriver, and if it does not do it well, or if it is broken, I call it a 'bad' screwdriver or a 'broken' screwdriver, but still a screwdriver anyway. This is different in physical science. If an electron does what electrons normally do, the scientist will not call it a 'well-functioning electron', but just 'an electron'. If it does not do what an electron normally does, the scientist will not call it a 'bad' electron or a 'broken' electron, but he then decides that it is a different particle. The physical scientist does not judge reality, but only describes it. Engineers do have an opinion about reality, and in fact what they do is talk about a desired reality rather than the actual reality. This normative dimension can also be seen in other categories of engineering knowledge, such as knowledge of norms and standards, knowledge of rules of thumb, knowledge of good practice and so on (Meijers and De Vries 2009). Natural and physical scientists have that kind of knowledge also, but then it is part only of their knowledge of the methodology of their discipline, never part of what they see as the content of their discipline itself (they do not see it at the same level as the laws of nature they discover). The immediate consequence of the normativity in technological knowledge is that values play an inherent role in technology. These can be purely functional, but often ethical values also come in. When do we regard a car as 'good'? Only when it brings us from A to B? Most people would not be content with that. A 'good' car is also one that is environmentally friendly, safe (preferably both for the driver and for other people that may get hit by the car in an accident), user-friendly, etc. The notion of normativity in technological knowledge stimulates a view of technology in which values are an integral element, contrary to much of the past in which we thought that technology is instrumental and neutral. Again we see that analytical philosophy, although it 'only' deals with conceptualising, does contribute to critiquing technology and our views of technology.

We also see this in the domain of methodology. Here we do not mean that term as a list of prescriptive phases or steps that can be taught to new designers. Methodology literally means: the study of ways in which . . . . (And then some activity should be added, like 'science' of 'design', which then leads to 'methodology of science', especially 'design methodology'.) In the early days of design methodology, it was suggested that ideal design flowcharts could be developed, irrespective of the field of design (Cross 1984). The overall structure of such frameworks was usually: analyse the problem – synthesise possible solution – evaluate against the criteria and choose for further elaboration. Now we know that (1) design is too domain-specific to make such general schemes work and (2) even within one domain, design problems and designerly ways of thinking differ so much that such schemes are too abstract and idealised to work in concrete and complex reality. Our intuitive ideas about design appeared to be too naïve and simplistic. We now recognise the complexity and variation of design processes much more than before. The same, by the way, holds for science (we also dropped the belief that something like ‘the’ scientific method exists). Prescriptive views of design stimulate deterministic views of technology. Again we see how analytical philosophy of technology points out that such a view is not supported by systematic reflection on the nature of design, engineering and technology.

1.6 Implications for Design and Technology Education

This chapter is meant to be a sort of ‘overture’ to following chapters in which lines will be drawn to education. I will, therefore, just make a brief transition here to those chapters and leave the more concrete applications to the authors of those chapters. We have seen that there are two modes of philosophical critique of technology: the continental and the analytical. Both have shown their value in the past. How far removed is all this philosophising from the practice of design, engineering and technology education? Unfortunately, often quite far. Educational practice still today often suggests a deterministic view of technology, in spite of the fact that we do a lot more design work than before. But as long as in that design work, we think that design processes can be prescribed according to a scheme that represents the ‘logical and optimal’ design process, we make students think that ‘it just has to be this way’. Similarly, we may hold to a purely descriptive view of technological knowledge. And again, similarly misleading may be a strictly non-relational view of artefacts as neutral instruments. Add to this the ideas we have seen in continental philosophy of technology in which values play a very important role. Those can be personal values (the quality of our individual experience of reality) or environmental, social and cultural values (relations between sub-cultures or social classes). Using both analytical and continental philosophy of technology will enable critique of an educational practice that implicitly or explicitly presents a deterministic perspective on technology. Such a perspective is not fruitful in the context of technological literacy (unless we define technological literacy in a very narrow and instrumental mode). Technological literacy implies that (future) citizens are not just able to use the technological devices around them properly, but also make sophisticated judgments about various aspects and phases of technological developments. In subsequent chapters of this book, this will be elaborated for various aspects of design, engineering and technology education.

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