How not to Distinguish between Science and Technology

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1. Introduction

Even at the cost of oversimplifying somewhat, we may distinguish three main arguments in favour of the distinction or even separation between science and technology[1]: 1) the distinction between so-called 'pure' science and its technical applications: the technique would later apply knowledge acquired in the first place and in a completely autonomous way by pure science; 2) the independence, and perhaps superiority, of the technical mastery of certain processes with respect to their theoretical understanding; 3) science and technology are similar in that both are a kind of knowledge, but they are different because they have a life of their own and developed differently in different times and places. According to this point of view, science and technology are in a relation of unity and distinction to one another: they are similar in respect of one set of its qualities, and yet dissimilar with respect to one or more of the others.

As we shall try to show, all the mentioned ways of conceiving the relationship between science and technology, at least in the precise sense in which they have been understood, are untenable. It follows that a coherent and more convincing conception of the relationship between science and technology has yet to be formulated. The third view seems, at least in principle, to be the most promising, butit was not able to provide a satisfactory explanation of the relationship between science and technology, especially because of eclectic solutions, which, as such, end up containing the difficulties of the positions that were to be reconciled. In fact, it should be pointed out that this paper is only intended to be the *pars destruens* of a broader project to be developed later, which aims to take up the idea, present in the third conception, of a relationship of unity and distinction between science and technology.

The paper is structured as follows. Sections 2 criticizes the more traditional view that technology is the mere application of a scientific knowledge that, it is alleged, grasps reality independently (Popper has been taken here as a paradigmatic example of this conception). Section 3 is devoted to the discussion of the account which strives to distinguish science and technology on the basis of the alleged autonomy of technology or technological rules with respect to the natural sciences; this account reverses in a certain sense the more traditional position: it is not technology that depends on natural science, but natural science on technology. Finally, Section 4 will show he difficulties and inconsistencies that affect the third position (and which will need to be removed in order to develop a coherent and more convincing intermediate conception).

2. The distinction between science and technology: the independence of natural sciences from technology

According to the more traditional view, technology is the mere application of knowledge provided by the natural sciences, which – so it is assumed, implicitly or explicitly – can grasp reality independently of technology. To simplify the critical examination of this conception, I shall take Popper as a paradigmatic example.(2) For Popper, technique is a mere application of scientific knowledge that is accepted as such on the basis of an epistemological criterion that is different from the technical-operational one, namely the criterion of falsifiability. It is against instrumentalism that Popper's distinction between "pure" and "applied science" is primarily aimed:

"Instrumentalism can be formulated as the thesis that scientific theories – the theories of the so-called 'pure' science – are nothing but computation rules (or inference rules) of the same character, fundamentally, as the computation rules of the so-called ‘applied’ sciences. (One might even formulate it as the thesis that ‘pure’ science is a misnomer, and that all science is ‘applied’.)”(3)

Popper's main objection to this thesis consists in pointing out that only theories of pure science, but not the rules of technological calculation, can satisfy the criterion of falsifiability: it only makes sense to falsify scientific theories, but not technical instruments or apparatus. In checking the latter, we must only try to ascertain their limits of applicability:

“every air frame, for example, can be ‘tested to destruction’, but this severe test is undertaken not in order to reject every frame when it is destroyed but to obtain information about the frame (i.e. to test a theory about it), so that it may be used *within the limits of its applicability* (or safety).” (Popper 1963[1972], 113)

A simple means of prevision cannot be falsified, since what may at first appear to us as its falsification “turns out to be no more than a rider cautioning us about its limited applicability” (Popper 1963[1972], 113). Any failure (say that of traditional navigation rules in air navigation) may lead us to reject our theoretical conjecture that they would be applicable in a certain field, but “they will continue to be used in other fields. (The wheelbarrow may persist side by side with the tractor.)” (Popper 1983, 114)

One can readily concede to Popper that an instrument, as such, cannot be falsified (or, we might add, verified): nobody would think that inability (or ability) to tighten a screw with a hammer proves the falsity (or truth) of the hammer. But this still leaves the basic theoretical issue unsettled. Terminology aside, the essential point is that a theory can be verified or falsified only *by means of the functioning of an instrument, of which it is the theory*. Therefore, the failure to tighten a screw with a hammer falsifies, for example, the hypothesis that a hammer is the right tool for that task (or, of course, any other hypothesis or conjunction of hypotheses that can be plausibly set forth to explain that failure, for example the hypothesis that we are unable to use the hammer appropriately).

Popper himself recognises this point implicitly when he admits (as we have just seen) that when we test an airplane to find out its structure's collapsing point, what we are really testing is the theory about that structure and its limits of applicability. Accordingly, *refutation is the outcome of a technical application*: we are dealing here with a proper experiment that tests a scientific theory by setting up suitable initial conditions (the construction of a structure with certain characteristics).

> In fact, far from proving the separation of the theoretical and technical aspects, this appears to directly confirm their unity. It is certainly not the airplane that is put to the test, but the scientific theory by means of the airplane's structure. If on the one hand, as already noted, an instrument or a technical device is hardly conceivable apart from some theoretical statements that it somehow embodies and exemplifies, on the other hand it is impossible to test a theory other than by instruments or technical artifacts. In short, Popper failed to realise that in his example the aerodynamic structure is one of those technical apparatuses that must be used necessarily to falsify or verify a theory.

3. The distinction between science and technology: the independence of technology from the natural sciences

Having discarded the traditional position that rejects the intrinsic connection between science and technology by asserting the independence of the natural sciences from technology, we must now turn to the opposite and less traditional view, which, while still affirming the qualitative separation of science and technology, it does it by maintaining that technology is independent of the natural sciences, and not vice versa.

This view strives to distinguish science and technology on the basis of the alleged autonomy of technology or technological rules with respect to the natural sciences. This position is nowadays held by some exponents of the "sociology of scientific knowledge" (often abbreviated as SSK) and of the "science-technology studies" (or STS), but sophisticated conceptions of this kind had already been developed by some French and German philosophers of technology, from Alexander Koyré (1961, 308) to Jacques Ellul (Ellul 1954), from Ferdinand Redtenbacher (1848) to Hans Rumpf (1973, 96) and Hans Lenk (cf. Lenk 1982, 50), or from Hugo Dingler (cf. 1913[1967], 208) to the leading proponents of the methodical constructivism inspired by Dingler’s work, such as Paul Lorenzen (cf. 1982, 749-750) and Peter Janich (cf. 1978, 13).

According to this view, technical or technological sciences are supposed to develop on their own, raising and solving new problems independently of the theoretical or pure research carried out by the natural sciences. The "technical sciences", far from developing the knowledge of the natural sciences only in the sense of applying it in the way a recipe is applied, would be able to lead by themselves to new discoveries on their own. In this view, the independence of technology is especially illustrated by its capacity of setting challenges to science by raising questions which science, on its own, would be able *neitherto raise nor to solve*. As Hans Rumpf writes:

“Technique does not proceed so as to make use only of scientifically clarified natural phenomena, but without hesitation invents, performs and works with their useful effects, even if it does not know their connection according to a law."[(4)]

To support this view it is often remarked that there exist processes that are not yet mastered theoretically (such as combustion in internal combustion and jet engines) but are mastered and applied technically, that is, even in the absence of a corresponding theory (cf. Lenk 1982, 50). As Redtenbacher pointed out already in 1848, this holds also for the construction of a machine. No machine can be invented with the principles of Newtonian mechanics alone: the invention of a machine requires, as well as an inventor's creativity, a precise knowledge of the mechanical processes that the machine is intended to carry out, practical knowledge of the materials that need to be worked, and skill in using the relevant tools.[(5)]

Some thinkers go so far as to uphold a certain superiority of the technical/technological over the theoretical sciences: while the problems of the construction of machines cannot be solved by means of mere knowledge from the natural and formal sciences, the performance of scientific experiments presupposes that the scientist has constructed the necessary instruments by applying a constructive-engineering knowledge tacitly assumed to be independent (cf. Erlach 2001, 20, who speaks of an "epistemological primacy" of technological knowledge. For a historical survey of the development of the technological sciences (and particularly of engineering science) as closely related to the developments of the natural sciences, see Channell 2009).

The following objections can be raised against these attempts to argue that technology is independent on science:

1) First, they rest on inconclusive reasoning, since their arguments still leave intact the thesis of the identity of technological and natural science.[(6)] The fact that technology is capable of posing challenges to science and of autonomously providing answers to problems that the latter had not even raised is not sufficient to demonstrate the irreducibility of technology to science. The same fact can be put

forward as evidence in favour of the rival explanation that there is an identity between technological and natural sciences: the fact in question is equally well explained by saying that it is impossible to practice technology without at the same time practising, even implicitly, science, in the sense of asking questions and offering answers that are always at the same time also necessarily cognitive. From the point of view of the identity of science and technique, technique is, so to speak, tautologically capable of exerting a decisive effect on many scientific discoveries (and vice versa): technique can pose new challenges and stimuli to science precisely because its essential link with the theoretical moment can never be completely severed. One might even argue that this last explanation is more satisfactory, since it avoids another difficulty of the position we are now examining: if technology were isolated from properly theoretical knowledge, the very claim of its influence on the latter would become very difficult to understand;

2) Second, and more important for our present purposes, in my opinion the attempts to argue that technology is irreducible to science rely on the untenable or at least dubious implicit assumption that the meaning of an experiment could remain unchanged even if the theoretical assumptions that define the meaning of the experimental question change. This objection need to be contextualized. The most recent attempts to defend the independence of technology with respect to the natural sciences have been strongly influenced by the experimentalist turn in the philosophy of science, which has stressed the decisive importance in science of experimenting and, more generally, of acting and operating. This is a very important point, but the "new experimentalism", in supporting it, has also succumbed to the temptation of opposing theory and experiment, unilaterally attributing to the latter the same autonomy and indeed independence that Popper, relativistic epistemologies and social constructivism had instead attributed to theory. Experimental practices are considered by the main

exponents of the new experimentalism as independent from linguistic-theoretical ones: unlike theories, experimentation "has a life of its own" (Hacking 1983, xiii). It is not difficult to see the untenability of this assumption. It is sufficient to note that one cannot indicate what an experiment consists of simply by direct ostension alone: ostensive definitions are meaningless and incomprehensible unless they occur within a specific theoretical context. The meaning of an experiment – its description, interpretation and relevance for a theory – cannot remain totally unchanged with the changing of the theoretical presuppositions which define the meaning of the experimental question. Two experiments, identical *as to the experimenter's actions and the experimental apparatus or mechanism*, can stand for two distinct experiments, or even two experiments in distinct scientific disciplines, if performed to answer distinct theoretical questions. Otto von Guericke showed that sound travels through water by always ringing a bell before he fed fish in a pond; but if we consider that the hungry fish arrived at the ringing of the bell, this experiment in physics could perfectly well count as a psychological experiment in animal conditioning. Or, to take another example (for this example, see Franklin 1989, 438-439), before 1905, experiments on the composition of velocities were considered the 'same' whether the velocities they involved were far from or close to the velocity of light, since Newtonian mechanics does not distinguished on this basis. After that date, in the light of the special theory of relativity, these experiments take on entirely different meanings and therefore should be considered different experiments (for more details about this fundamental difficulty of the new experimentalism, see Buzzoni 2008 and 2015).

The last considerations introduce us to another way of drawing a distinction between between science and technology that is worth a more careful examination.

4. The distinction between science and technology as a distinction between different types of knowledge and/or as a real-historical distinction

According to another way of distinguishing science and technology, science and technology are in a relation of unity and distinction to one another: they are similar in respect of one set of its qualities, and yet dissimilar with respect to one or more of the others. They are similar in that both are a kind of knowledge, but they are different because they have their own characteristics, which mean that they have a life of their own and developed differently in different times and places.

In one variant of this proposal, for example, technology consists in knowing how (certain goals may be attained), without necessarily knowing why (they are attained in this way). In other words, the efficacy and success of technical knowledge emerge implicitly, without having to be able to give explicit reasons of their success. This idea was already in Abel Rey's mind, when he wrote that the decline of Greek science after the second century was resulted, at least in part, from the fact that Greece relapsed into the earlier utilitarian interests in oriental techniques, and for this reason was not able to find the unity between "savoir-faire" and "savoir rendre raison des choses" (Rey 1948, 121; but see also Koyré 1961, 307-308), that is, as we might interpret it today, between "knowing how" and "knowing why". More precisely, it must be admitted that there is a difference in principle between science and technology, but they are like the branches of a tree which spring from, or root in, a common trunk: science and technique are seen to be similar in that they are both, at least in a very general sense, types of knowledge.(7)

The fundamental error of this position consists in understanding the distinction between knowing 'how' and knowing 'why', so to speak, in ontological terms, as a dichotomy between two ways of knowing that stand on their own. However, the distinction between knowing ‘how’ and knowing ‘why’ is acceptable only functionally, as it were, as a distinction concerning both the theoretical and technical aspects. What counts as ‘knowing why’ at a certain cognitive level, appears as a given, as ‘knowing how’ at a further level where deeper questions rise; this deeper questioning changes the previous ‘knowing why’ into a given (a ‘knowing how’) in need of further explanation.(8)

For example, one could think that we only have a ‘knowing that’ about the functioning of the more common household appliances; but what is *prima facie* a ‘knowing that’ (say, that the dishwasher is turned on by pushing a certain button, with no deeper knowledge of its functioning) for a child may well be a ‘knowing why’. To the child’s question *why* the dishwasher has started making that noise, we may reply, for instance, that this happens just ‘because’ we pushed a certain button which turns it on. Likewise, we can distinguish between our knowledge ‘that’ the dishwasher does not work and the technician’s knowledge of ‘why’ that is the case (say, "because the condenser is broken"). However, the technician’s ‘knowing why’ is, from the point of view, say, of an electrical engineer, a ‘knowing how’ which in turn calls for an explanation as to ‘why’ the condenser is broken – and so on without end, at least in the sense that it is not possible to establish a frontier beyond which science can progress no more.

One could respond by adducing *prima facie* more convincing examples supposedly demonstrating the possibility of a mere ‘knowing how’. Many technical improvements proceed from chance discoveries and can further improve without probing the reasons behind this improvement. For example, if an angler all of a sudden caught many more fish than usual and noticed that the hook had been accidentally bent for some unknown reason, from then on that angler may always use that hook and may also bend it more or in different ways actually producing more efficient hooks.

At first it would appear that the angler has no insight into the reasons of his undeniably technical behaviour. But if we look at the example more closely, it soon becomes evident that this is not the case. The angler would have never embarked on the search for more efficient hooks had he not noticed that the hook worked better *because it had been bent*; and this is a knowing 'why', it does not matter at how elementary or low a degree. Without this *explanatory* hypothesis, the angler would not have progressed to using the bent hook systematically, let alone to improving on it technically. In the course of the historical development of scientific knowledge, a split developed between those who operate in the field of basic science and those who operate in the applied sector; but this does not call into question the fact that science can know only by acting and intervening technically in reality, and that this intervention, insofar as it is not blind but has some access to its reasons, is from the very beginning to some degree scientific.(9)

This is also the key to answering an objection that might appear crushing and that has been urged repeatedly for separating science from technique and vice versa: the identity of science and technology is implausible because, historically, technique preceded science. One of the earlier formulations of this objection is due to Jacques Ellul:

"The first techniques of Hellenistic civilization were Oriental; they were not derived from Greek science. Thus, historically speaking, the relationship between science and technique ought to be reversed. […] Even in physics, in certain instances, technique precedes science. The best-known example is the steam engine, a pure achievement of experimental genius."(10)

On reflection, the essential or qualitative difference between ancient technology and modern (techno-)science depends at least upon two core assumptions: (1) the real-historical distinction, between science and technology, and (2) the qualitative distinction between ancient and modern technology. We have already discussed and rebutted the first assumption; but what about the qualitative distinction between ancient and modern technology?

There is no space here to discuss this view at the length that it deserves, but two considerations may indicate where difficulties lie. First, for reasons similar to those already given in the case of the distinction between knowing 'how' and knowing 'why', also the difference between ancient and modern technology is only acceptable as a pragmatic or functional one, concerning both theoretical and technical aspects.

Ancient technology, just as modern technology,was always in some degree also science. It too was founded upon, and at the same time could possible yield, empirical knowledge about the world (to use Heidegger's term to our purposes and probably against Heidegger, an "alethic" character is to be ascribed both to classical *techne* and modern technology), but it is evident that ancient technology, if judged from the standpoint of our subsequently gained knowledge of the world, was fragmentary and full oftheoretical and practical assumptions, which were just taken for granted and which had not been subjected to a careful scrutiny.

According to the pragmatic or functional character of the distinction between *knowing how* and *knowing why*, of which we have spoken, the most archaic technology is also always, in some measure, scientific technology (or technoscience), no matter how low the critical attitude of the initial users could be.

If, on the contrary, the distinction between *knowing how* and *knowing why*is thought of, not as a functional and pragmatic one, but as drawn once and for all, then it - though intended to separate technique from science and, on this basis, ancient from modern technology – in actual fact only separates animal from human technique. In the human sphere all “knowing how to do”, even in the weak forms of habit and/or compulsion to repeat, *qua* knowing, involves at no matter how infinitesimal a level a noetic aspect of critical awareness.

Many studies suggest that the ability to use tools is an important indicator of advanced cognition in animals, especially in social animals, who outperform nonsocial animals when presented with problem-solving that requires tool use. (Borrego and Gaines 2016). Animals too, it must be conceded, interpret their environment and thereby use something similar to our concepts, but (with all the caution due when talking about animal capacities) these ‘concepts’ probably lack the human prerogative of criticality, that essential openness that lets them be freely modified according to the changing of situations. For this reason, it is useful to distinguish explicitly and accurately between these types of pre-human skills and skills that form part of the signifying context of human life.

To avoid the objection I have been urging, and to attempt to maintain the difference between science and technology, one might try to take an intermediate position. The now prevailing version of this view (which however can already be found in Jonas 1979, 37) is indeed the thesis that there is a mutual feedback or an “interaction” between science and technology. It is admitted that they are not subordinate to, or dependent on, one another, and that it is a historical fact that science and technology exist today in such a state of mutual interaction, correction, and integration, but it is argued that 1nevertheless there are some important differences between them (cf., for example, Nordmann 2016, 120, and Niiniluoto 2016, 93 and 98-99).

The main problem with this account is that it simply assumes that science and technique are in principle, both epistemologically and historically, independent entities, each of which can be considered in isolation from its relations to the other. But this is precisely the assumption which we showed to be untenable in the two opposite ways of separatingscience and technology we have been examining so far. For this reason, we may reject this account without further examination: since it simply assumes the separation between science and technique as its unquestioned basis, it stands and falls with this presupposition.

Conclusion

As we have shown, all the ways of distinguishing or separating science and technology that we have examined have proved implausible, if not incoherent and untenable. In all the cases examined we have shown that it is not possible to disavow either the technical nature of scientific knowledge or the conceptual-theoretical mediation proper to human technique. As far as intermediate views are concerned, they seem, at least in principle, to be most promising, but, in fact, they were not able to provide a satisfactory explanation of the relationship between science and technology, especially because they have adopted eclectic solutions, which, as such, end up containing the difficulties of both positions they seek to reconcile.

As a result, a more convincing conception of the relationship between science and technology has yet to be formulated. In fact, as already mentioned, this paper is the *pars destruens* of a more general project that intends to take up and develop the thesis of a relationship of unity and distinction between science and technology, trying to avoid the difficulties and inconsistencies common to all the positions examined here. To anticipate our working hypothesis, to achieve this goal it is necessary to draw a distinction in principle between two perspectives from which both human beings and the products of their knowledge and action can be considered and evaluated.(12) But that is another story.

Notes:

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(2) In the context of this paper, for reasons which will become clear subsequently, I shall use the words "technology" and "technique" interchangeably, taking "technique" in the broad sense in which, for example, Ellul writes that "[t]he technical operation includes every operation carried out in accordance with a certain method in order to attain a particular end. [...] It can be as rudimentary as splintering a flint or as complicated as programming an electronic brain." (Ellul 1954[1964], Engl. transl., p. 19) From my point of view, the distinction between "technique" and "technology" is only fruitful, or even necessary, if understood as a distinction between between technique and discourse on technique: it is clear that the concept of technique cannot be defined by technical means (cf. fn. 8).

(3) For a more detailed discussion of Popper's view, see Buzzoni 1982 (especially ch. 3, Sect. 4). Among the more recent representatives of this point of view, see for example Feibleman 1961 (who however also distinguishes applied science from technology in a narrow sense), Layman 1989, Vincenti 1992, Ropohl 1997, Cordero 1998, Niadas 2000, Hendricks et al. 2000, Hughes 2009, Niiniluoto 2016.

(4) Popper 1963[1972], 111; cf. also Popper 1983, 107-8. On the meaning of "applied science" in today's discussion, see for example Boon 2006 and Karns Alexander 2012.

(5) Rumpf, 1973, 96. In a similar way, Erlach 2001 maintains that the efficacy of a technological rule can be established independently of the knowledge of a causal law: "In order to obtain a rule, it is sufficient to establish, by induction, some statistical *correlations* in the connections that are supposed to conform to a rule. Insofar as these correlations do not fail, one knows the efficacy of the rule – without knowing the causal relations that 'are at its foundation'" (Erlach 2001, 14-15) For a more cautious but similar formulation, see Rapp 1978, 69-71.

(6) Cf. Redtenbacher 1848, v-vi. For more recent accounts that

maintain the independence of the engineering sciences in relation to the natural ones, see Houkes 2009, Nordmann 2006 and 2016, and Boon 2011. Nordmann speaks of two "radically different modes of knowledge-production" (Nordmann 2016, 120 fn.) For Nordmann, we should not underestimate "the difference between controlling phenomena and explaining the world with regard to notions like 'causal analysis,' 'modeling,' or 'validation'", since "these terms (like 'knowledge,' 'theory,' 'explanation,' etc.) have different meanings in scientific and technoscientific research" (Nordmann 2016, 120 fn.). In a similar vein, Boon 2011 tries to distinguish methodologically between science and technology as respectively between "knowledge about stable objects (including stable relationships such as phenomena, regularities and causal connections), and knowledge about how to use or make or intervene with these objects — in other words, knowledge that represents the world (or Nature or the universe) and knowledge about interventions with the world." (p. 53)

(7) This view, which is nowadays a minority opinion, is relatively frequent in the science-technology studies, where it is often accompanied by the term "technoscience", which was originally coined by Gaston Bachelard and successfully revived by Bruno Latour, and which signals the unacceptability of the clear-cut distinction between science and technology. Barnes, one of the leading exponents of the sociology of scientific knowledge, writes: "We recognize science and technology to be on a par with each other. Both sets of practitioners creatively extend and develop their existing culture; but both also take up and exploit some part of the culture of the other [...] . They are in fact enmeshed in a symbiotic relationship." (Barnes 1982, 166) More generally, as Trevor Pinch and Wiebe Bijker, who are also leading exponents of the 1sociology of scientific knowledge, have written in a gloss on this passage: "[i]n his [sc.: Barnes's] view the boundary between science and technology is, in particular instances, a matter for social negotiation and represents no underlying distinction." (Pinch and Bijker 1984, 404) But also more independent philosophers, as Martin Carrier, have defended such a view. According to Carrier, at least in regard to contemporary science, technology and science tend to coincide

with one another because the scientific object are not the things in nature, but - following Bachelard's notion of "phenomeno-technique" - the technological artifacts: "Recent natural science seldom addresses entities and processes that exist independently of human intervention." (Carrier 2011, 44) This thesis, in fact, will not be directly discussed here and, therefore, will neither be accepted nor rejected, remaining a theoretical possibility still to be evaluated in a different place from that of this paper, which is dedicated only to the rejection of the distinction or separation between science and technique.

(8) Cf. for example Blumenberg (1953, 119), and Feibleman (1961[1966], 302): the question of "how" is the "primary technical question" (Blumenberg), and technology "is more apt to develop empirical laws than theoretical laws, laws which are generalizations from practice rather than laws which are intuited and then applied to practice." (Feibleman) In a similar way, Rapp (1978, 69-71) stresses that the engineering sciences limit themselves to the question of "how" (as distinct from the question of "what"), but recognises that all the empirical sciences, and not only the engineering sciences, are expressed by means of conditional propositions: if the conditions from which determinate consequences follow are known, it is sufficient to produce those conditions in order to obtain the desired result. More recently, cf. above all Agazzi 2014 (305-306) and 1999, and Niiniluoto 2016, 100

(9) For the distinction between "knowing how" and "knowing why", see also the position developed by Abel 2018 and 2019, which I consider from several points of view essentially in agreement with the critical considerations made here.

(10) From this point of view, as already mentioned in footnote 1, also the distinction between "technique" and "technology" is fruitful, and perhaps necessary, in only one of its meanings, namely as the distinction between technique and discourse on technique, because the concept of technique cannot be defined by technical means. In an inquiry into the epistemological status of the philosophy of technology, therefore, it would be useful to distinguish, on the one hand, technique as a general term for everything that had been a result of intentional activity, and, on

the other hand, technology as a general term for a second-order critical notion or understanding of technique. On the contrary, the distinction between technique and technology cannot be accepted as valid in the sense that the former is a pure knowing how to do things lacking knowledge of the reasons of this doing, while the latter is an efficacious knowledge that draws its nourishment from a specific background of "theoretical knowledge" (Agazzi 1992, 77), or takes "science as the source of […] theoretical justification" (Agazzi 2014, 307). As we have pointed out, in the human sphere all 'knowing how to do', even in the weak forms of habit and/or compulsion to repeat, *qua* knowing, involves at no matter how infinitesimal a level a noetic aspect of critical awareness. In this sense, the distinction between technology from technique in actual fact only separates human from animal technique.

(11) Ellul 1954[1964], Engl. transl, 7; see also Koyré's article "Les philosophes et la machine" (*Critique*, 1948), reprinted in and quoted from Koyré 1961, where the objection in question is already to be found (see especially p. 308). For other instances of this argument, see for example: Ihde 1979, xix; Granger 1989, 58; Lenk 1982 and 1994, 22; Niiniluoto 2016, 96-97. We encounter this line of argument also Heidegger, but in a conceptual tangle that Ihde 2010 (cf. above all ch. 2) has successfully unravelled.

(12) For this distinction between a reflective-transcendental and a methodological perspective, see Buzzoni 2008 (concerning thought experiments) and Buzzoni 2020 (to understand two apparently opposite, but in fact complementary, aspects of our relationship with technology: technology's inexorable capacity for extending itself into every field of our life, and our capacity to counteract and orient technology, at least in some measure.

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