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INTRODUCTORY REMARKS ON ONTOLOGY OF TECHNOLOGY

Waldemar CZAJKOWSKI

Silesian University of Technology, Gliwice, Poland; wczajkowski@polsl.pl, ORCID: 0000-0003-4603-6984

Purpose: Technology, understood as a complex and evolving system, still lacks a systematic theory. Such a theory would be both theoretically and practically important. The paper presents an outline of such a theory.
Design/methodology/approach: Conceptual analysis availing of general ontology, using analogies with such branches of philosophy as the philosophy of science, and drawing upon general knowledge about history of technology.
Findings: A method of classification of the problems of the ontology of technology has been constructed and its usefulness – demonstrated. A certain number of trends in the evolution of technology have been identified.
Research limitations/implications: The field studied in this paper is very broad. Further studies of its sub-fields identified in the present text are badly needed.
Practical implications: Social/political implications can be regarded as a type of practical implications.
Social implications: The paper can have some social implication, though rather indirect: analytically clear and substantially comprehensive ontology of technology should support broadly understood technology policy and especially its more direct theoretical foundation – axiology of technology (a part of technology assessment).
Originality/value: The paper presents a systematic overview of the problems of the ontology of technology.

Keywords: ontology, evolution of technology.

Category of the paper: viewpoint, general review.

1. Introduction

The phrase “ontology of technology” contained in the title of this text is much less frequently used than the “philosophy of technology” (Rapp, 1981; Borgo, Vieu, 2009, Vallor, 2022). For this reason, a few brief remarks on this phrase should be formulated (Durante, 2022).

Let us commence with a comment on the word “ontology”. It has been in use in philosophy since 18th century and has designated a branch of it. Sometimes it has been used as a synonym of “metaphysics”, sometimes – as the name of a part (the most general one) of metaphysics (Thomasson, 2009).

In this paper the term “ontology” will be used in the way close to (though not identical with) the one proposed by the great German philosopher – Edmund Husserl: he introduced the notion of “regional ontologies” that study the most fundamental and general properties of various domains (“regions”) of the Being (the Reality, the Whole…) To avoid too long and too detailed considerations, I will limit myself to giving some examples. Social ontology and ontology of works of art, ontology of mathematical objects and ontology of everyday life – these are. perhaps, the most widely known examples of regional ontologies.

Now, I would like to say a few words on the reasons that prompted me to use the phrase “ontology of technology” as the name of the intended field of my studies. Firstly, in accordance with some very general philosophical views I do accept, I want to distinguish two types of philosophical discourse (in particular: about technology): descriptive (ontology) and normative/evaluative (axiology). I tend to believe that just in the philosophy of technology (and in some other branches, e.g.- political philosophy or historiosophy) these two discourses are too often intermingled - I formulate this opinion in a cautious way: its justification would demand a separate analysis. (Mitcham, 2022) I should add that, in my opinion, axiologies of technology presuppose ontology of technology. This relation should be characterized by the way of analogy with mathematical theories: e.g. both Euclidean and non-Euclidean geometries presuppose propositional calculus.

I would also like to draw reader’s attention to an analogy between philosophy of technology and philosophical anthropology (= philosophy of man). Still today at least “folk philosophical anthropology” (cf. “folk psychology”, “folk physics” etc.) contains ideas about man as being “inherently bad” or “inherently good” (many similar also). Such opinions have very little, if any, sense. Similarly, in my view, to ask whether technology is “inherently good or “inherently bad” has no more sense. Of course, technology can (and should) be evaluated. But how to evaluate technology – rationally? (Grunwald, 2009) To sketch an answer to this question, let us avail again of the analogy with the philosophical anthropology.

Already Aristotle discussed many various sorts of moral and intellectual virtues (virtues can be understood as values characterizing human beings). Just this analysis demonstrated that it is impossible to “aggregate” all these virtues into one “all-embracing” Virtue. It should also be noted that Aristotelian definitions of virtues presuppose descriptions of various types of situations in which people find themselves at times and analyses of various kinds of actions undertaken by them in those situations. In short – ethics presupposes (explicitly or implicitly) ontology of man, and of action, (more profound analysis would demonstrate that also – this of society). – Similarly, any rational evaluation of technology (its axiology) should be based on a systematic description of technology – on an its ontology (Banse, Grunwald, 2009).

The decision to use the term “ontology” as a name for the analyses to be carried out in the present text has had a few motivations. The most important has been presented in the previous passage. The intention to apply some ideas taken from general ontology (Durante, 2022) has also played a role. And last but not the least: the domain to be studied here overlaps with an area of interest of social ontology (today well-established discipline connecting social philosophy and general/theoretical sociology), and with that of the ontology of Nature (a term less often, for various reasons, used than the previous one, but – in my opinion – designating a legitimate field of philosophical analysis; incidentally a field of particular importance in the time of the global ecological crisis).

Still two terminological remarks. First: As noted above, the word “ontology” is sometime used as a synonym of the word “metaphysics”. But even if the denotations of these two terms are regarded as identical, their connotations can be different. The term “metaphysics” suggests close relations with, say, religion or poetry, while “ontology” – rather with logic or physics. – Just the last associations fit better with my intentions.

And second – on the word “object” (Beth, 2009; Preston, 2009). It will be used here in the way characteristic for ontology (at least, for many its currents): both a stone and the whole Universe, a John Smith and the whole humanity, the set of complex numbers and the number “two”, the history of Japan, and the life of Burek (a dog), a concrete chemical reaction… – these are all objects.

At the end of these introductory remarks I want to present an assumption determining the structure of this text: While studying some domains of the Reality, it is convenient to distinguish two aspects of the given domain: its structure and its history; for instance, social ontology (in the most conventional meaning of this term) focuses on the structures of social reality, while historiosophy – on its history Thus, the second chapter will be devoted to the analysis of the structure of technology, and the third one – to the analysis of the historical process of the technology development (of its evolution) In the last, fourth, chapter, I will formulate some remarks on the issues that should be analyzed in the future.

2. A "structural" ontology of technology

I would like to start this chapter with some very general methodological remarks concerning the importance of classifications (taxonomies), in particular – of the classifications of scientific (philosophical) problems. I think that one can offer at least three arguments supporting the "importance-thesis". The first one might be named "logical": Theoretical problems are not, so to say, "logically independent". On the contrary, they are in various ways interconnected. If to accept the opinion that a single solved problem generates (at least: most often) a certain number of new problems, one must accept the thesis that the total number of (unresolved) problems increases. It can be also assumed that knowledge of the "problem-surrounding" of a problem is one of preconditions of its understanding. If so, some instruments representing "location" of this or that problem are more and more important.

The second argument may be called "heuristic": a classification of problems should help to find still unnoticed (thus: unresolved) problems.

And the third one I would like to name "pragmatic". Even philosophy, not to say about so-called "applied sciences", is not (at least: not only) developed for its own sake. In the epoch of the exponential growth of the production of scientific texts a "map" ("maps") of problems become more and more practically indispensable.

If you accept these arguments, you should accept my decision to divide philosophy of technology into fields, sub-fields etc. (Of course, acceptance of this general decision does not entail acceptance of the specific way in which I have realized this decision; perhaps a better division could be proposed.)

The motivated in the "introductory remarks" division of the philosophy of technology into its ontology (the only subject of this paper) and its axiology (the subject of the paper of Przybylska-Czajkowska, 2022) is the first step. The division of the ontology of technology into the "structural" and "dynamic" (or, if you prefer, "historical") is the second one. Now, the third step will be made: The "structural" ontology will be divided into "internal" and "external".

Though the labels ascribed to the two sub-fields of "structural" ontology suggest what is the nature of their problems, a few words should be made on this distinction. The "internal" ontology contains – among others – a classification of technical objects and/or relations between them. And the relations between technology and other element of the social/natural world constitute the subject of the "external" part of the "structural" ontology of technology. No more steps in this classification are intended. Thus, let us pass to the "internal" ontology.

This part of my considerations will be commenced with some, rather short, comments on the definition of the term "technology" (Mitcham, 2022; Mitcham, Schatzberg, 2009). Quite a lot of place (time etc.) has been devoted to the discussions around this problem. I am not going to join these debates: I am not convinced that definition of technology is necessary. I think that an alternative strategy of the characterization of various domains (of art, of sport, of religion…), in particular – of technology, can also be useful. Briefly put (though more formal characteristic might be given): This strategy is based on indicating a group of objects undoubtedly belonging to the given domain (here: to technology) and on indicating other objects connected with the objects of the first group by relations of some special kinds. (Two methodological remarks. The first step could be characterized as so-called ostensive/deictic definition. And as regards the second step, the analogy between this strategy and the so-called recursive definitions – e.g. of natural numbers – may be helpful.)

I would even risk the thesis that the characteristic of the "core" of technology is a rather simple task. Especially, if one starts from an idea fundamental for the modern European: the idea – most explicitly expressed by such thinkers as Kant, Fichte or Husserl – of both the distinction, and strong interconnections between Subject and Object (by the way, it seems to me that a pair of engineering sciences concepts – this of "controller/regulator" and of "controlled/regulated system" – can be regarded as a special case of these two philosophical terms). If some relations between Subject and Object are – as philosophers, following Hegel, like to speak – "mediated" by another object, this "mediating" object deserves the name "instrument" or "tool" (Beth, 2009).

I have used both these terms because – from the historical point of view – some natural objects (a stick, a stone etc.) should be regarded as instruments though not as artifacts. On the other hand, not all artifacts can be regarded as instruments (e.g. various pails of rubbish etc., also – the ozone hole; the instrumental status of such artifacts as, for instance, Egyptian pyramids or Stonehenge monuments, would deserve not conceptual but substantial debate). It seems obvious that that technology includes instruments (tools) and (some) artifacts. – In this way the "core" of technology has been defined. Now let us make the next step.

Material objects are actual (and not only potential) instruments if some humans can use them – if they have certain skills (if they dispose some practical knowledge). These skills (this knowledge) will also be regarded as a part of technology. A question arises here: which skills should be regarded as a part of technology? For instance: is literacy a part of technology? I would say that in some historical periods (e.g. in the 21st century) the answer should be positive. In the Ancient times – rather negative. The same can be said about "mathematical literacy".

Let us stress now that the concept of instruments can be – to use a term adapted from mathematics – iterated: some instruments can be used to produce instruments necessary to produce other instruments… – Theoretically, the number of iterations is not limited. A similar remark might be made in relation to skills: skills can be produced by trial and error or by instruction. And the skill necessary to instruct can be produced also by instruction. Etc.

Still today we use knives and hammers – to butter bread or to fix a nail in the wall. These objects can be characterized as instruments of consumptions. But think about airplanes or computers and about instruments necessary to produce these objects. And instruments necessary to produce these very instruments. Etc. Etc. – I want to suggest here two things.

First that the whole technology owned by a society (at a given time and place; e.g. the global society in the year 2022) can be regarded as one object (not necessarily as one system – in the very strict sense of this word) that can be characterized in a certain number of ways. Secondly, the highest number that can be (theoretically!, practically – only very roughly estimated) ascribed to an instrument could be regarded as a characteristic not only of this particular instrument but of the whole technology.

I would like to make an additional comment on the iterated definition of instruments and on skills to use them: An assumption is accepted here: There exist instruments that control instruments that control other instruments…, but these "initial" (or, viewing from another side, "end") – in this chain – instruments are controlled by humans (possessing necessary skills). This assumption seems to be – still today – (almost) obvious. But what about more or less distant future: is self-regulated (totally autonomous) technology possible? – In the epoch of the development of Artificial Intelligence such a question does not seem to belong to philosophical and/or literary speculation. It is a question deserving serious debates. – Here, I have to limit myself to this remark

Ending these considerations on (the concept of) technology, I would like to make a general remark on the structure of social world. I think that it is neither necessary nor possible to draw sharp border lines between various domains of social worlds: between politics and sport, between science and art… It does not mean that we should not distinguish these areas. I only want to stress that these areas overlap. – If you accept this opinion, you should also accept (if hypothetically only) that any of these domains – including technology – could be viewed as fuzzy subset (in the precise sense of the mathematical theory of fuzzy sets) of the social reality

Such an approach would result in regarding such domains of the social reality as religion. poetry, or language (Coeckelbergh, 2022) as elements of technology (though, perhaps, of very small degree of membership). And , on the other hand, in regarding technology as part of art or politics. – So much about the "core" of technology.

Let us now pass to the "mereology of technology" (I apply here the term coined hundred years ago or so by the Polish logician – Stanisław Leśniewski; this term refers to theory of relations between parts and wholes; in spite of some similarities, these two concepts should be understood as fundamentally different from those of "element" and "set" characterized in the theory of sets developed by Cantor, Zermelo, and others; Vermaas, Garbage, 2009)

To present a systematic mereology of technology, one should write a whole (rather large) book. At this place, very short remarks on the field will be given. Let us start from reminding the notion of simple machines. According to the standard view, their set contains: lever, wheel and axle, pulley, inclined plane, wedge, screw. – They are elements (parts) of more complex machines.

Leaving aside moral considerations, there is little doubt that from descriptive/historical perspective there are reasons to regard also (domesticated) animals – e.g. oxen, horses or camels – as instruments/tools.

Formulation of this remark gives opportunity to say a few words on technical systems. Ox pulling plough is one of simple technical systems. Also: horse or tractor.

It seems that separately "great" technical systems should be analyzed. Perhaps the railway network is the first instance of this type of systems, and the Internet – the most complex one. (Dietrych, 1985). The first aspect of the "greatness" of such systems can be very simply defined: these systems encompass either whole globe or a large part of it (say, a whole continent). And to describe the second aspect we could use the term "complexity". How to measure it? – It seems that the simplest way is to estimate the number of different types of technical objects constitutive for the given system. The interconnection between these two aspects seems to be fundamental for grasping the specificity of the "great" technical systems. It should be added that defining this class of technical systems is not only the question of classification/taxonomy. More importantly, this taxonomical decision is motivated by the conjuncture that just the systems of this type play very special role in society – in economy, politics and culture.

Railway network or Internet – however complex (composed of very different sub-systems) – are rather "specialized" systems. But there exist objects that can be regarded as complex technical systems but rather "universal". I mean here towns and cities (Illies, Ray, 2009). Let me stress that in this context I use (for the sake of brevity) these terms in a rather narrow sense – as designating material/technical systems. In other contexts (especially those of social sciences and humanities) these terms can be used in more broad sense: as denoting systems composed of humans, material systems and symbolic/cultural sphere. Returning to the narrow interpretation of these concepts, let us add that so-called "smart cities" confirm this interpretation of cities as "universal" technical system in particularly evident way.

As stressed above, technology comprises not only various non-human objects but also – human skills (Mitcham, 1994). And to the description of skills also, the mereological concepts should be applied. A systematic discussion of this issue would need large references to philosophical anthropology and philosophy of action. Such references are not possible here. Let me give but one instance illustrating the intuition I mean: Let us consider the skills of jet pilot. They make up very complex system of perceptive skills, of ability of (fast) analyses of various (both natural and social) situations, of the relevant knowledge of technology and weather (the basis for diagnoses), of decision-making… (Kroes, 2009).

I would like to end this part of my considerations with s discussion on an issue that can be classified as belonging both to the "internal" and to the "external" parts of "structural" ontology (Brey, 2022).

Instruments/tools, technical procedures, technological knowledge can be classified in various ways. (Let me stress that at least some of these classifications seem to be equally important, therefore complete classification should be multidimensional.) As one of the most important classifications can be regarded the one that is based on a classification of the (material) world. According to a widespread view, we can distinguish matter, energy and information (Brey, Soaker, 2009). If we accept this view, we can introduce the classification of instruments/tools into matter preserving/transforming, energy preserving/transforming and information preserving/trans- forming. – This classification can be developed. For instance, we can distinguish devices affecting inorganic and – organic matter (or both), transforming chemical energy into mechanical, nuclear into electrical etc. In short: the structure of technology (more precisely: a "dimension" of this structure) reflects the objective structure of the world. Thus, ontology of technology presupposes ontology of the Nature.

Having said this, we have entered the "external" part of the structural ontology of technology. This part contains analyses concerning the relations between technology and – "our" world. Some comments on this formulation seem desirable.

Firstly – on "our" world. This phrase is to denote a part of the Universe comprising our planet (including Homo sapiens, other species, artifacts etc.) and its "surrounding". How large is this part depends on our real (material and not formal, set-theoretical or other mathematical) relations (interactions) with the Universe. And anticipating further considerations (on the dynamics of technology), I would say that just due to the development of technology "our" world is getting greater and greater. It should be also noted that we do not know how large "our" world at the given moment is: we neither know precisely which part of the Universe exerts (significant - ?)) influence on our planet nor we know what are all effects of our activity on ("our" part of) the Universe.

Secondly – on the structure of "our" world. I think that we should divide (conceptually, theoretically) "our" world into two parts: "human" and "extra-human". There is no doubt that these two "worlds" overlap and interact. Humans and their material artifacts belong to the border-area ("intersection") of these two worlds. Perhaps, another formulation could be complementary (or alternative?): The whole "our" world could be viewed as "human" and the Nature as a part of it. The whole "our" world can be also viewed as the Nature and the "human" – as its sub-part. Without continuing these considerations, I would like to stress that these conceptual deliberations and troubles reflect real and profound ontological problems and difficulties. Despite these difficulties we should not forget that technology is a part of the world studied by physics (chemistry, biology…) and that investigated by sociology (psychology, cultural anthropology….). And this conceptual distinction is an instrument to remind us the importance of these problems.

According to our conceptual decisions, "external" ontology studies relations between technology and "the rest" of "our" world (Brey, 2022). I think that it is both convenient and substantively justified to distinguish two basic types of these relations. To put it more precisely, I assume that two types of relations between humans and the world can be distinguished, and thus two types of instruments: The first type of relations can be named "transformative", and the second – "cognitive". It is obvious that these two types of relations are interconnected; it is also evident that some instruments can be used as "transformative" or "cognitive" (e.g. some medical instruments used both for diagnosis and for treatment). But, making as previously emphasized, analyses of interrelations (interconnections, interactions) presuppose making distinctions. In the context of these considerations, it could be said that the structure of technology (owned by the given society – localized in a fragment of the social Space-Time), reflects (more or less exactly) the relative importance of the "transformative" and "cognitive" attitudes (interests) of the members of the given society.

The issue discussed in the last passage directs us to a more general problem – that of human needs. The last concept, quite widely used in psychology, is often rejected by many philosophers and social scientists. Without going into this matter, I want just to declare my opinion: I am convinced that this concept is not only useful but – just indispensable (But one should distinguish between general opinion on the importance of this notion and opinions on the methodological and empirical values of this or that theory of needs). In my opinion, good theory of needs should be founded on a good theory of man (philosophical anthropology). Does such theory exist? At this moment, I know no answer to this question.

3. A "dynamic" ontology of technology

According to the decision discussed at the beginning of this text, we are passing now from the "structural" to the "dynamic" ontology of technology (incidentally, while writing this paper, I found on the Internet information about a relatively new field of study - 'technology dynamics'). It should be clear that in the previous chapter technology was viewed as a complex of objects existing in a "short" interval of time (one for which the assumption that this complex is not changing is – at least approximately – valid). And in this chapter technology will be viewed as developing complex of objects. In other words: we will focus on a process – a process that can be recognized as evolution: technoevolution/evolution of technology (Lem, 2014).

By analogy to the division of "structural" ontology of technology, also the "dynamic" ontology will be divided here into two parts: "external" and "internal". However schematic this divide may be, it should also be useful. In particular – to emphasize the conviction I accept that both the perspectives in which the history of technology can be viewed ("from inside" and "from outside") are equally important. Let me add that this approach is also motivated by the lessons that can be, I think, learnt from the philosophy of science: Quite a lot of time has been spent on debates between proponents of internalism (e.g. Imre Lakatos) and those – of externalism (e.g. Thomas Kuhn). According to the opinion I do share (it can be only declared here; for a justification a separate text would be necessary), these debates have been – at least to a large extent – waste of time and effort.

Before passing to more detailed analyses, I want to make here a remark on the most general ontological concept to be used in this chapter, i.e. to the concept of "process". The objects denoted with this term are similar in some respects to such objects like material things or sentences: in particular, processes can be parts (in the mereological sense of the word) of larger objects (processes) and can be composed of more elementary objects (parts: processes). To invoke a well-known instance: Anabolism and catabolism are processes that make up metabolism; on the other, both these processes are very complex – both composed of many more elementary processes.

Before I pass to the discussion of these two fields ("internal" and "external"), I would like to formulate some general comments on the subject, concepts and problems of the "dynamic" ontology of technology.

First comment – on the subject: One could say that this part of the ontology of technology shares its of interest with the history of technology, but – contrarily to this branch of historical sciences – it focuses its attention not on individual facts (inventions, inventors' activities etc.) but on historical trends and their determinants (Headrick, 2011). To underline this characteristic of "dynamic" ontology of technology, one could suggest an alternative name for this domain: historiosophy (= philosophical history) of technology.

And second: any serious "dynamic" ontology of technology (or, if you prefer, its historiosophy) presupposes that its area of study does exist. Wanting to avoid the feeling of paradox, let us put this remark in an alternative way Any serious historiosophy (of technology or of science, of religion or just of universal history) assumes that the history of the given field does exist – that the history is "something more" than just a collection (a sequence) of events. In other words, it assumes that not only individual events exist but also that trends (tendencies, regularities, mechanisms…) do exist.

Third remark: The assumption formulated in the previous comment can be rephrased as follows: History of technology is a(n) (actual) process. This formulation directs our attention to general ontology that distinguishes processes as a special sort of histories (sequences of events). Without discussing this issue, let us give a few simple instances: a sequence of the drawn numbers (in a lottery) does not represent a process and the sequence of numbers representing temperature of one's body in a short time represents a process (development of an illness). In still other words: by process is understood a deterministic history (determinism can be stochastic). If a history is not deterministic – it is not a process (A set of difficult problems has been indicated here. In a larger text much more attention should be given to these issues).

Fourth, such a large process as the history of technology can be regarded as an evolutionary process (Lem, 2014). Having accepted this thesis, we can speak about evolution of technology. Introducing this notion is, I believe, very important. It suggests significant analogies between history of technology and such processes as general history of human culture, the history of life on the Earth, and even – the history of the Universe.

Having made these short remarks, let us pass now to the “internal” ontology – to the description and analysis of the evolution of technology, as seen “from inside”. A whole book would be necessary to present – systematically and comprehensively – evolution of technology, even if viewed only in this way. Thus, I will confine myself to presentation of a list of trends accompanied by their characteristics.

The list can be regarded as hypothetical – and in a double sense: First, in the case of each presented trend, its very existence and its characteristic should be regarded as hypothetical (to be confronted with empirical/historical material.) And second: In still more hypothetical way, it will be suggested that these trends (all?, most of them?) are among the most important internal trends in the evolution of technology.

The first trend: from simple and primitive instruments to more complex and less primitive (e.g. stone tools: from Paleolithic to Neolithic). Having at our disposal a taxonomy of tools, we could make more precise this formulation. We could speak about evolution of (such “species” of tools as) knives and spears, listers and ploughs, or cars and planes. It seems to me that this hypothesis (cf. remark above) has quite strong intuitive-empirical support.

The second: toward greater and greater differentiation of instruments. I mean differentiation in a double sense. To avail of a biological analogy: On one hand, the increase of the number of “species” – cars and planes, satellites and spaceships, computers and mobile phones…. – to name but the very view out of the immense number of the new “species” developed in the 20th and 21st centuries. And on the second one: Have a look a tool kit of a plumber or other mechanic – ten, twenty or perhaps even more, types of screwdrivers only... The increasing differentiation of a single “species”: the rise of “sub-species”.

The third trend: toward new applications (Rosenberger, 2022) of already existing tools. As it is well-known, wheel was one of the most fundamental inventions in the history of human civilization. Firstly, due to its revolutionizing role in the development of the means of transportation – the development that has had great many – more or less direct – consequences: civilizational, cultural, economic, political, social… But, secondly, it has had other innumerable applications: quern-stones and water-wheels, elements of clocks, turbines and electric motors. And much more recently: computer. For the last seventy-five years or so it has quickly gone a long way from a very limited number of applications to the almost all-embracing kinds of use. (Of course, it is but a part of the story; various processes – in particular: miniaturization – have played enormously great role in this process.)

The next (fourth) trend. In short: from individual devices to – one global techno-system (techno-sphere; note the analogy with the concept of eco-/bio-sphere) This trend, except for its two hypothetical aspects it shares with the other trends presented here, has still one aspect of this kind – predictive. As far as I can guess, one global techno-system has not existed, and – in the near future – will not. But in a more distant future, the existence of such a system is, I suppose, possible. To estimate the probability of the realization of this possibility, more profound (and methodologically comprehensive) analysis would be necessary. Due to this (very hypothetical) prediction, the analysis of this trend would deserve special attention.

Now, let us finish the debate over this prediction, and let us return to this trend viewed in the perspective of the current and the past history. Some elements of the image seem to be evident: the history of the technology begins with individual tools. The agricultural revolution is connected with the rise of "complexes of tools" (comprising some tools for soil cultivation, but also some pottery for the storage of grain etc.), and the (first) industrial revolution – with the rise of factories (systems of machines).Last but not least, let us mention the world-wide systems: of (civil) aviation, of the mobile network, and of the Internet.

In describing the fifth trend, I will avail of one of the central ideas of the Leslie White's theory of cultural evolution. As its key element White regards the development of technology, and – as the central part of this development – the evolution of the energy production. According to White, five epochs of this evolution can be distinguished. In the first one man uses energy of his body (of his muscles). In the second – he uses the energy of domesticated animals (! – animals as instruments/tools). In the third one – that of plants, in the fourth – of natural resources (such as coal, oil etc.) and in the fifth epoch – nuclear energy.

The sixth trend can be regarded as analogous and complementary to that described by White. This trend was characterized by Gerhard Lenski. In his view, the development of the instruments of communication (transfer of information) is one of the most central elements of the cultural evolution. He distinguishes four epochs: In the first (it could be, I think, called pre-human) parents pass genetic information to their children in the way similar to that characteristic for (other) animals. In the second, people pass their own experiences by demonstrations, gestures etc. In the third – signs, language and logical thinking becomes the basis of human communication. In the fourth – writing starts to play crucial role in communication (Lenski's model should be confronted with that of the great English biologist John Maynard Smith).

With the seventh trend, I pass to analyses of the "human side" of technology. There is little doubt, that the number of the types ("species") of human skills has increased. I do not want to claim that all skills our ancestors possessed in the more or less distant past have survived until today. Quite contrarily: many, sometime very sophisticated, skills have died out. But great many new ones have been born. And, it can be supposed, that the second process is faster than the first one. Thus: a positive balance between these two processes.

The previous trend characterizes, so to say (using, not incidentally, a popular term), "global human capital". But this global capital can be analyzed in another way. We can analyze also the differentiation (or: social distribution) of this global capital. The issue is more complex than the one discussed above. The respective trend may also be more complex. For this reason, my discussion of this problem will be rather sketchy. Look first at the contemporary situation. On one side: very complex and sophisticated skills of jet pilots or managers of nuclear power plants. On the other: (some) McDonald's employees or the workers on the production line

(Realization of A. Smith and W. H. Taylor's ideas). If to pay attention to the most general aspect of this trend, one could suppose that the distance between the most complex labor force and the simplest has been increasing. So much about the sixth trend.

And a remark on the development of technology. In whatever way we would like to describe this process theoretically (as more or less directional, deterministic, etc.), and whatever its theoretical explanation we would offer, a simple empirical fact remains: the difference between technology that existed one hundred thousand years ago and technology existing today in enormously great. If so, as an empirical fact (to be interpreted, accounted for etc. but not – questioned) must be recognized the accumulation of technological innovations, and – particularly – their generation (Buchanan, 2009; Dors, Overveld, 2009).

Following analyses of Jose Ortega y Gasset, I would like to outline a model of a trend characterizing the process of generation of the technological innovations.

According to this prominent Spanish philosopher, periodization of the evolution of technology should be based upon analysis of the interconnections between man and his technology. Ortega y Gasset distinguishes three types of technology: (1) technology of incidence/chance, (2) technology of craftsmen/artisans, and (3) technology of technicians. We should, as I believe, to add to this list the fourth element: (4) technoscience (Buchanan, 2009).

So much about "internal" dynamics of technology. Let us pass now to the "external" perspective. It should be both substantially justified and convenient to distinguish two parts of this perspective: On one hand, the influence of the "external" reality on technology; on the other – the influence of technology on the "external" reality.

How we could describe the first domain? I want to start from some well-established facts and from some questions these facts generate.

First fact: technology has developed in different parts of the worlds (civilizations/cultures, societies etc.) in various ways. Particularly: the pace of technological development has been extremely different. Still in the 20th century you could have found some (though very few) groups using Paleolithic tools, some (a bit more numerous), using Neolithic technologies, the majority – owning modern technologies, and – very few – disposing ultramodern technologies.

And second fact: even the most technologically advanced societies have developed in various epochs with different pace.

What factors can account for these (evident, undisputable – in any serious way) facts? Historical sciences deliver a certain number of answers to this question. For a detailed overview of the relevant ideas a separate (and rather large) text would be necessary. But they often differ as to details only; thus, they can be classified and connected into few groups. It seems to me that one can start from three groups of theories.

The first group contains conceptions emphasizing the role of the natural environment. They often distinguish three general types of the environment (Note that this taxonomy is not "purely" ecological/geographical: it starts from relations between humans and natural environment). One of these types can be characterized as "easy-to-live" (e.g. Polynesian islands), the other – as "difficult-to-live" (e.g. Greenland). Both are regarded as not conductive (though for different reasons) to technological development. Only "intermediate" environment (neither "too-easy" nor "too-difficult") is regarded as "technology-favorable" (Note the Aristotelian intuition present in this conception).

To the second group you can include theories stressing the importance of social relations (social structures, social institutions). It seems to me that these theories are "structurally", so to say, analogous the previous ones: Both the "anarchic" and "totalitarian" societies are, according to these theories, unfavorable for technological development. Only societies with strong but limited power/authority can support development of technology.

And the third group. It could be called "culturalist". It comprises theories focusing on the world views (philosophies in the very broad sense of the word): on the images of the world (as "mysterious" or "cognizable") and of the man (as "autonomous" or "dependent"). Culture in which "cognizability" of the world is connected with the "autonomy" of man is, according to these theories, most supportive to the development of technology.

Ending these few passages, I would stress the connections of the issues mentioned there with two widely debated in historical social sciences problems: of the rise of modernity/capitalism, and of the specificity and the role of Europe.

Let us now turn to the second domain of the "external" ontology: to the changes in the influences of technology on the world. I would like to emphasize here the importance of the word "changes": My fundamental, history-based, intuition is that it has little (if any) sense to speak about the role (particularly: "positive" or "negative") of technology - regardless of time and place.

I think also that it should be convenient to make a further distinction and speak about the influence of technology on the natural world and on the social world (that these two types of influences are interconnected is evident and needs no further comments).

Remarks on the influence of technology on the natural world (Kuenkel, 2019) I would like to start with some words on the recently very popular term: "Anthropocene". This term expresses, in a concise way, very important idea: the whole "our" natural world has become an object of our (though not intentional) activity. This idea entails a related one: of the historical process of the growth of the power of mankind over its natural environment. These two interconnected ideas seem to contain (much) more than a "grain of truth". But they need further analysis. This analysis should consider the necessity of distinguishing two concept: of the power of mankind over its natural environment and the "power" of technology over the natural world. Perhaps the growth of "power" of technology over Nature will turn out connected with the weakening of human power over technology? – In this question substantial and analytical problems are intermingled. Their unraveling has to remain a task for another occasion.

And now some comments on the influence of technology on the social world. It is a huge subject (a multi-voluminous book could be written). I would like to concentrate our attention on three interrelated issues: on transport, on communication, and on urbanization.

Viewing transport from the technological perspective, we would not have to distinguish between transport of things and transport of people: wooden carts and ships, cars and airplanes – these and similar devices have been used for both types of transportation. But if we are speaking about social consequences of the development of transport, this distinction is important: e.g. the economic consequences of long-distance trade in grain or beef on one side, and the cultural consequences of international tourism on the other – are different. I am going to focus on the transport of people. And not on many its consequences but on one of them only.

Incidentally, the consequence I mean here is also a result of the process of urbanization. Just for the sake of order: urbanization has been an effect of the industrial revolution(s). The growth of such mega-cities like New York, London or Shanghai and Mexico-City is a part/consequence of urbanization. Some additional economic and political factors have decided that only some of mega-cities (New York rather than Shanghai, London rather than Mexico-City) have become "worlds-in-miniatures" – places in which live people of various races, speaking great many languages etc. There is little doubt that development of transportation has contributed considerably to this process.

Another technological development – the development of the Internet – seems to have an opposite consequence: if you can talk with other people via Internet you can leave you home (office etc.) But it is not so. People are in touch with others "on-line", but for various reasons they travel if they can.

4. Final remarks

The last ten-fifteen decades have been time of very quick and very profound changes – perhaps the most quick, and the most profound – throughout the history of mankind to date. It has been the time of two world wars, of genocides, of many man-caused disasters… But it has been also the time of great development of medicine, of great successes in the struggles with pandemic and mass hunger… – There is no way to formulate one, total, definitive and unambiguous valuation of this epoch (Perhaps it could be added: it is "more impossible" in relation to "our" epoch than to any previous one. Briefly put, we may have lived in the most "paradoxical" times).

Therefore, this epoch has been and will remain a subject of many academic debates, political controversies and ideological quarrels. Some points seem, however, beyond any meaningful discussion. Beyond any discussion is the fact of the immense development of technology (probably greater than that in the whole previous history). Beyond any discussion is the large impact of technology on the virtually all domains of our individual and social life.

But technology, just due to its great power, contributed to the immensely variegated, extremely ambiguous image of the (still un-ended) epoch. – Therefore, no simple assessment of technology in general, and of the contemporary (20th-21st centuries) technology particularly, can be formulated (Briggle, 2022).

On the other hand, just for the same reasons, we are today much more aware that assessment of technology (Grunwald, 2000, 2009; Vermaas, 2022) is much more necessary than ever: Such concepts as the industry 4.0 (or the fourth industrial revolution), transhumanism (Hansson, 2009) or technological singularity… – direct our attention to the future of technology. They make us ask questions about the current and future trends of the technology development (Hitachi, 2020).

To ask these questions and seek answers to them, we have to understand technology. And here a new problem arises: To use the phrase proposed by the prominent Polish philosopher and writer Stanisław Lem: we live in the epoch in which "megabyte bomb" has exploded. There is no place and time here to discuss the various factors that determine this phenomenon. Also, there is no place and time to analyze its various consequences. But there is little doubt that these are (at least: to a considerable degree, if not - mainly) negative.

I am convinced that philosophy has today an important role to play: to (try to) counteract the negative consequences of the "megabyte bomb" explosion. How? – This question is easy to be formulated and difficult to be answered. Nevertheless, the main idea can be presented rather simply: The main task of philosophy is to construct "synthesis" ("syntheses"?) of the knowledge about man, about the world s/he lives in, and about the problems her/his activity in the world generates (Kuzior, Czajkowski, 2019, 2021). (The exact meaning of the term "synthesis", the methodology of its construction… – these are the problems that make difficult the possibly complete and justified answer to the question with which the present passage has been commenced.) This thesis can be applied to all branches of philosophy. In particular – to the philosophy of technology.

This conviction has determined the construction of this text: The concept of "synthesis" comprises, in my opinion, at least two ideas: First – the idea of possibly simple, transparent, consistent and compact language. And second – the idea of a "map" (or – of a certain number of trees /graphs/) presenting the structure of problems.

It is obvious that construction of a "synthesis" is a difficult task. Particularly, it cannot be said in advance which is the best strategy to realize this task Thus, many attempts should be undertaken.

My text is but the first step toward a version of philosophical synthesis of knowledge about technology. Over the next few years, I hope to make next steps.

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