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The Case for a New Discipline: Technosphere Science

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ABSTRACT

This paper submits the philosophical case for establishing 'technosphere science' that draws on results of many other disciplines, reaching from physics to the social sciences and humanities. I present claims about the type of entities that are studied by technosphere science and their causal relationships, and introduce central organizing concepts, such as 'information' and 'function'. Agency is no longer seen as a property exclusive to humans, but as being distributed in networks of ontologically diverse entities. Technosphere science draws on various uses of the concept of 'networks' across disciplines, such as scaling laws and builds on a universal evolutionary framework that generalizes over biological evolution. In this perspective, the economy is the medium by which human action becomes functional relative to the reproduction and growth of the technosphere. I conclude with showing how human autonomy and ethical commitments remain possible.

1. Introduction: Do We Need a New Science of the Technosphere?

The definition of the new geological epoch of the Anthropocene centres on one specific phenomenon, namely the massive occurrence of human artefacts in the most recent geological sediments (Williams et al., 2016; Zalasiewicz et al., 2017a). These artefacts are the products of human technological creativity. Some authors have introduced the term 'technosphere' for identifying the origin of these artefacts and referring to its systemic totality, ubiquity and pervasiveness in the Earth system (Haff, 2012; Haff 2014b; Herrmann-Pillath, 2013: 485ff). The term is increasingly adopted in the emerging field of Anthropocene studies (e.g. Donges et al., 2017). In this paper, I submit a radical claim: I defend the view that we need a new scientific discipline for the study of the technosphere, and I will discuss basic conceptual aspects to provide its foundations. It is necessary to establish a new science of the technosphere in analogy to biology as the science of the biosphere. There is a problem of linguistic design here (see Arthur, 2009: 12ff) since 'technology' already appears as an '-ology', therefore I leave it with 'Technosphere science', in analogy to 'Computer science' or 'Geoscience'. Yet, the term 'technosphere' motivates considering a new disciplinary frame, because it deliberately creates the analogy to the 'biosphere' as well-established concept in biology and the geosciences.

The alternative would be to confine ourselves to the term 'biosphere' (Smil, 2003) and to approach technology as created by humans as a subsystem of the biosphere: Apparently, this is the view that often prevails among ecological economists (for example, Brown and Timmerman, 2016). Obviously, that would lead us to question the term 'Anthropocene', too: If nothing is new under the sun of the biosphere, why should we diagnose a new geological epoch, as recommended (Zalasiewicz et al., 2017b)? The alternative suggestion of 'Anthropocene studies' seems to be under-determined, because it refers to the geological epoch only, without further specifying a particular empirical domain and type of objects of inquiry. In the geological notion of 'Anthropocene', this is narrowed down to the analysis of the corresponding geological phenomena, such as sediments, which would preclude, say, the explicit study of the human economy just because it emerged in that geological era.

My exercise is an ontological one, hence should be received as a philosophical work, in the sense of a science-based ontology à la Bunge (1977). Doing ontology means to reflect basic categories of 'being' and establish their systematic relationships. As such, ontology is fundamental for any kind of science, especially in defining the characteristics

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of certain scientific disciplines vis à vis the others (in the context of Ecological Economics, see Spash, 2012). So, for example, many philosophers of chemistry would argue that 'substances' stay at the core of chemistry as being different from physics and biology (van Brakel, 2000); biology focuses on 'life', which raises the ontological question how we characterize 'life' as a basic form of being that differs from non-life (Mayr, 1982); or, economics resolutely rejects any causal claims that would assign existence to supra-individual entities ('methodological individualism') (Rosenberg, 2001). So, if we wish to establish 'technosphere science', what are the most fundamental ontological constituents? Evidently, this might be 'technologies'. However, this seems to stay in tension with the basic inspiration of the concept of 'Anthropocene': In the latter, humans seem to reign absolutely, and technology is just a human creation (hence, the "human age", see Monastersky, 2015). Yet, if the central phenomenon embodied in the geological strata is the artefacts that are parts of the technosphere, we might ponder whether a better designation of that geological era would be the 'Technocene' (as Cera, 2017 recommends; compare Haff (2014c), Brondizio et al., 2016). As we shall see, that is not merely playing with words: A fundamental question in studying the technosphere as the defining feature of the Anthropocene is the status of human agency in its evolution.

Regarding human technology, there is no specific science devoted to the study of it. On first sight, that might be engineering, however, this is the science of creating and applying technology, and not the science investigating the phenomenon as such (see the discussion in Mitcham, 1994). Apart from engineering, the study of technology is fragmented across many disciplines, such as 'Science and Technology Studies' as a field in the humanities and sociology, the cultural sciences and anthropology, economics, or complexity sciences, just to name a few. The reason for this seems to be rooted in a hidden ontological assumption, namely that technology is the product of human action and design, and that it serves human purposes. Accordingly, if we study humans, that would include technology, if we move beyond engineering. As said previously, this may be implied by the term 'Anthropocene'. There would be no need for a 'technosphere science beyond multi-disciplinary research into technology as a product of human action.

As cross-disciplinary cooperation is the clarion call in modern science anyway, why further fragmenting our struggle for consilience (Wilson, 1998) in adding another discipline? The answer should emerge from this paper, but I give the two main reasons already here. If I refer to 'discipline' I do not mean 'subdiscipline', in the sense of cognitive neuroscience being a subdiscipline of neurosciences, or financial economics being a subdiscipline of economics. My first criterion for identifying the need for a new discipline, following Bunge, is the phenomenon of emergence of new systems properties that cannot be reduced to laws, regularities and phenomena that are treated by existing disciplines. Of course, the issue of reduction is contentious as such (many physicists think that chemistry can be completely reduced to physics, but many chemists disagree, though not all of them). Thus, to defend my view I must show that the technosphere manifests phenomena that are irreducible to other sciences, such as economics or biology. The second criterion is that we deal with a distinct ontological domain in terms of entities (like 'substances' or 'molecular shape' in chemistry, Ramsey, 2000). Therefore, I must demonstrate that technological artefacts are not objects of the same kind as rocks, trees, or humans.

If these two criteria are fulfilled, mere cross-disciplinary cooperation will not be able to catch the essential properties and autonomous regularities in the object domain of the technosphere. In other words, even if we (as I do) activate many cross-disciplinary resources in understanding the phenomena, we would not be able to identify the object of research properly. Writing as an economist, I compare this with establishing 'the economy' as the object of economics as a separate discipline in the process of the unfolding of disciplinary variety in the emerging sciences of human societies in the late 19th and early 20th century. Although today we observe intensive cross-disciplinary interactions in dealing with economic phenomena (e.g. behavioural economics), these continue to manifest distinct methodological and theoretical features in terms of their integration with economics (for example, psychology and experimental economics differ in principled respects even if studying the same behavioural phenomena with parallel references to game theory, see Tyler and Amodio, 2015). I leave it open to the reader whether this means to put technosphere science on the level of economics vis à vis the other social sciences, or to put it on the level of the social sciences vis à vis biology. I adopt the latter view, but this may be in the eye of the beholder.

I suggest a 'Copernican turn' in the study of the Anthropocene in raising research into the technosphere to the status of an independent scientific discipline comparing with biology. There are precursors to this view, such as Herbert Simon's (1996) notion of the 'sciences of the artificial' (which, interestingly, include economics). The radical nature of this step is to reject the implicit anthropocentrism of the notion of the 'Anthropocene': In simplest terms, if we notice the ubiquity of artefacts in geological sediments, I take it for just what it is, namely evidence for the emergence of the technosphere. And the technosphere is the sphere of technology, in which humans play a role, but not necessarily the central role. Compare it with the study of biology in the context of ecosystems that are massively shaped by human intervention: We would not define 'life' as a phenomenon that became 'human' for that reason and would not substitute biology by anthropology.

Technosphere science draws on many disciplines, reaching from engineering to economics, the social sciences or biology. This is straightforward to see if we look at existing research on technology. We can approach technology in many ways:

- We can adopt the engineering and science perspective, which defines technology as artefacts that mobilize physical phenomena in the broadest sense: this is a conception that is also often adopted by economists (Arthur, 2009). It would exclude other kinds of artefacts, such as a symphony, on first sight. However, evidently a symphony activates physical phenomena, too, so that we meet a first issue in discussing technosphere ontology: What is 'physical' about artefacts? The engineering and science perspective is essential in technosphere science because it highlights physical mechanisms and constraints that operate in the evolution of the technosphere. In Ecological Economics, an important pertinent research agenda is defined by Industrial Ecology (Ayres and Ayres, 2002). As we shall see, this implies, among many other insights, that energy and energetic transformations are a major object of study in technosphere science; this compares, for example, with mainstream economics in its current state, which treats energy only in specialist subdisciplines (Hall et al., 2001; Kümmel et al., 2015).
- We can adopt the social science perspective in recognizing that artefacts always tie up with human action, in various ways. This relates to both the producer and the user side of technology (which is today also emphasized by engineers, see Spreng, 2016 in the context of energy research). In this view, technology is not centred on artefacts primarily, but on the behavioural patterns, routines or institutions that govern the actual performance of artefacts in the context of human societies. In the social sciences and the humanities, this has sometimes led to the conclusion that all technology, and even science, is socially constructed, thus radically questioning the narrow science and engineering perspective (overview in Sismondo, 2008). Within technosphere science, we need to balance such opposing views and aim at a synthesis. In any case, in the technosphere artefacts and human action, mediated by human sense-making and interpretive creativity, are deeply enmeshed with each other.
- Another perspective is provided by biology. This is suggested by various arguments. A classical approach in the philosophy of technology approaches technology as extensions of human organs (originally suggested by Kapp, see Berger, 2014); in a more modern