Metamorphosis of the technosphere. A tribute to Dirk Messner, intellectual, politician and friend

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1. Global co-operation in the Anthropocene

The work of Dirk Messner covers a broad range of themes, from the challenges of global cooperation to the digital transformation and the future of energy provision to the climate crisis, but his contributions are all characterised by a strong will to address fundamental problems of humanity by drawing on all available intellectual resources and by focusing on what can be done concretely to solve them. This combination of a Renaissance-like intellectual scope and incorruptible pragmatism is rare, if not unique, and makes him one of the most important voices in today's discussions about humanity's global challenges.

In my contribution to this Festschrift I follow up on some of his thoughts on human cooperation in the age of the Anthropocene. The stimuli his work holds for future research in this field, for instance about the behavioural roots of global cooperation, are so rich that I can only touch upon one point that I find particularly remarkable: the bridge that Dirk and his collaborators have constructed between the findings of developmental psychology, evolutionary cultural history and the study of international relations (Messner & Weinlich 2016).

In more recent studies Dirk has squarely addressed the challenges of the Anthropocene and what they imply for the governance of global commons

and for the future of urbanism and mobility, for example. In this paper, I discuss a key analytical tool for understanding our predicament in the Anthropocene, the concept of the technosphere. It mostly explores theoretical issues which are, however, as I believe, relevant also for the questions close to Dirk's political concerns about global cooperation.

I want to start from the perspective of Earth system science and then suggest how it may be reconciled and more strongly integrated with approaches rooted in the humanities and the social sciences. In particular, I want to take up the question of how the human-constructed technosphere can be conceptualised not as a technocratic alternative to politics but as a framework in which global cooperation and politics can become a meaningful answer to the challenges with which the Anthropocene confronts us.

2. *Rules for the technosphere*

The notion of Anthropocene emerged in outcry against an inadequate description of the geohistorical state of the planet, inadequate because it did not acknowledge the thorough modification of the planet through human industrial activities. Taken literally, the Anthropocene is a technical term that focuses on a specification of geological epochs and eras. From an Earth system perspective, however, the Anthropocene is more than a geological sequence: it is a shift in planetary affairs; it designates, in other words, the planet's new state.

Contemplating this new planetary state and its relation to human powers, a number of scientists have assessed this development to be akin to the introduction of a qualitatively new Earth sphere, one that joins the other natural spheres: the biosphere, hydrosphere, lithosphere and atmosphere. Human activities and their impact can no longer be seen to simply extend from biological evolution, as a kind of 'biology with brains', since they go beyond the biospheric state of the planet. Proposals to name this new sphere range from 'anthroposphere' to 'noosphere' to 'technosphere'. While the label may seem to be a simple matter of convention, it is central in characterising the nature and dynamics of the changes induced by humans. What the term 'Anthropocene' does for stratigraphy, the study of sedimentary layers, a new Earth sphere does for Earth system science: it deals with the human impact on the planet as on a par with other geological forces, including that of the biosphere itself.

Recently, the notion of technosphere has gained prevalence over alternative proposals, and for good reason. It emphasises the human-made

fabric of industrial technologies, infrastructures, harnessed energy sources, social institutions and powers, and knowledge and belief systems. But what exactly makes this wide-ranging set of technologies and techniques a 'technosphere', and what are its defining features? In a trail-blazing paper, the Earth scientist Peter Haff claimed in 2014 that the technosphere operates quasi-autonomously, and he summarised these autonomous dynamics in six rules. The rules of "inaccessibility" and "impotence", for instance, state that "large components of the technosphere cannot directly influence the behaviour of their human parts" and that "most humans cannot significantly influence the behaviour of large technological systems." The rule of "provision" states that "the technosphere must provide an environment for most humans conducive to their survival and function" (Haff 2014).

Haff arrived at these characterisations, which shimmer between resignation and a residual trust into some bleak form of salvation, by mimicking a method of statistical physics. The method adopts an intermediate level of resolution for a 'coarse-grained' description of a system in which only collective behaviour matters, such as in describing highway traffic by considering only the density of cars on the road but not the individual cars. In more recent writings, Haff emphasises the challenges posed by ongoing technological acceleration and arrives at an even more sceptical assessment of our planetary predicament – one that would spell disaster unless we are able to slow down this accelerated development (Haff & Renn 2019).

But how realistic is this assessment and how useful is the underlying description of the technosphere? To what extent does this technosphere concept prolong the problematic conception of technology as a device used to elevate oneself above and separate from nature, imposing its own logic on it, rather than considering how technology stands as an intermediary between humans and nature and, in that way, as something that occupies a flexible and negotiable position between them? The former position pervades both affirmative and critical assessments of technology from Plato to Heidegger, whereas the latter has been emphasised, within the European tradition, by thinkers such as Hegel and Marx, although it goes back to a much older and broader tradition. In this essay, I would like to briefly comment on these conceptual demarcations of the technosphere's role, given its significance for our understanding of the Anthropocene and for our future prospects as a species confined, for the time being, to a single planet.

3. The technosphere as a borderline problem

In earlier writings on this issue I suggested an alternative concept for the new human-made Earth sphere, the 'ergosphere' (Renn 2020: ch. 16). I conceived of it as a sphere of human 'work' (Greek ergon) characterised by the transformative power of human labour, both with regard to the global environment and humanity itself. It encompasses the cumulative effects of human interventions, including technology and infrastructures, but also the impact of works of science and art, all of which express human needs, desires, fears, hopes and insights. In contrast to Haff's claim that the technosphere is essentially autonomous and preserves itself like some kind of superorganism, I emphasised how the ergosphere is open to different ways of shaping the relationship between humanity and its planetary home. The ergosphere concept thus pays tribute to the transformative power of human labour and offers more room for taking into account processes and practices negotiated politically and scientifically. In that sense, it does justice to Dirk's view that global cooperation may suffer from blockades but is not impossible on principle, for instance behavioural, grounds.

It is true that the development of technology is accelerating, with consequences that are sometimes unforeseeable and often uncontrollable. There are also planetary limits that we should avoid overstepping if we want to avoid risking the collapse of societies. And there is the immense heterogeneity of humanity and its asymmetries of power, which does, as Haff writes, make it difficult for most humans to influence the behaviour of large systems. He is also right when he claims that the technosphere, as a complex regulatory system, is self-organising. Its self-reproduction by the renewal or exchange of its human and technological components is controlled by structures – societal or technological –, which tend to persist through such changes.

But we should not forget that these structures may change gradually in an evolutionary process or, under certain circumstances, even break down. As a consequence, the resilience and long-term stability of the technosphere is not guaranteed, just because it can self-organise. Instead it seems to me that the future is not predetermined: the new Earth sphere has some plasticity, and it can even be shaped by our interventions to become favourable to the flourishing of human cultures and also to global cooperation – provided that we get a better handle on its dynamics.

The concept of technosphere turns out to be widely used, without any strict adherence to Haff's six rules, implying that a largely autonomous system is governing us, with little chance of being governed by us. This leaves room for, and perhaps even necessitates, a new definition of the

technosphere that does justice to the actual use of this term, but also to the insights of history, political science and anthropology that I have attempted to capture with the notion of ergosphere.

Rather than deriving the properties of the technosphere from a physics viewpoint, I propose to consider it instead as a borderline problem of different perspectives and disciplines.[1] By this I mean that the technosphere can only be adequately described by taking into account and bringing together different systems of knowledge, just as one can only understand humans when considering them as biological, cultural, social and indeed technological beings. In the same way that digital computing can only be understood as the result of addressing borderline problems across different fields (e.g. solid-state physics, mathematics, information science), the concept of the technosphere belongs, in equal measure, to diverse fields of knowledge whose methods need to be brought together to really appreciate it as a borderline problem.

This integration may come with major repercussions for the different frameworks involved in the process, because borderline problems require different perspectives to be related to each other, not in an abstract or meta-theoretical way but in terms of a concrete challenge. This is clearly the case for the technosphere. As an Earth sphere it falls under the domain of the Earth system sciences, but as a human construct it also falls under that of the social and human sciences. What, then, are the consequences for our definition and understanding of the technosphere?

Before coming to my preliminary proposal for rules to define the technosphere as a borderline problem of the natural and the human sciences, which include the social and behavioural sciences as well as the humanities, I need to address a key issue for such an integrated perspective, one that brings together quite different approaches and attitudes. Let me illustrate my point by referring to what Dirk and his collaborators have called the 'cooperation hexagon', describing basic enablers of cooperation, such as reciprocity, trust, communication, reputation, fairness, enforcement and we-identity (Messner, Guarín & Haun 2016).

The hexagon spells out important preconditions for successful co-operation that should be applicable, at least in principle, not only to small groups and societies but also to global cooperation. From this perspective it becomes legitimate – and this is the highly original thought of Dirk and his collaborators – to ask whether and to which extent failing international co-operation may be due to an underprovision of the prerequisites of

1 For a discussion of the notion of borderline problems, see Renn (2020: 81).

cooperative behaviour at the level at which this co-operation actually takes place.

So far, the analysis of these prerequisites has largely relied on recent results of the behavioural and social sciences which need to be extrapolated to the political realm. The hexagon thus defines co-operation as a borderline problem of the behavioural and social sciences. But many of the underlying conflictual issues have actually been dealt with also by the humanities which offer a rich treasure of human experiences not limited to the focus of the behavioural sciences on human behaviour as something to be observed in current practices or laboratory settings. Adequately framing cooperation as a borderline problem thus requires an even larger perspective that also takes these historical experiences into account, and this is, as I understand, what Dirk and his colleagues have in mind.

4. Which narratives count?

History often comes in the form of narratives. But which narratives count and can help us to address this challenge? It is, in my view, not just a matter of taking the insights of the Earth sciences seriously. The challenge is actually larger, as we need to incorporate the multifaceted experience of our species into our stories about an altered planet, including the conditions of its planetary existence and coexistence with other species. In telling evocative stories about existential threats to these conditions, we should neither belittle them nor reinforce the ever-present tendencies for self-destruction, which may even present themselves as tempting escape routes from impending disasters.

Narratives are forms of linearising complex networks of relations. Building networks is itself an emancipatory act because it relates different origin powers to each other, each assuming exclusive rights, and offers the chance to find a balance between them. As the theologian Paul Tillich pointedly observed, origin myths answer the question of where we came from by referring to the authority of such origin powers.[2] They claim that what came from the origin must inevitably return to it, be it the social group, soil and blood, or 'Nature'. Origin myths are at the root of all conservative and romantic thinking in politics, Tillich writes.

But human beings are capable of breaking the biological cycle of birth and death by creating their own cultural reality, in which the origin

2 See, also for the following, Tillich (1977).

powers threatening to devour us can be withstood, for instance by bringing them into a balance, but for which we then must take responsibility. Hesiod's mythology, which created the Greek polytheistic pantheon, is an example of such a balancing act, constructing a divine aristocratic model society from a conflicted human history encoded in competing origin myths. The form that the narrative linearisation of networks takes is evidently not indifferent: it may reveal or hide conflicts and suggest different modes of dealing with them.

In addressing the Anthropocene in our narratives, we should be wary of reproducing archaic forms of thinking, giving in to temptations presented by origin powers. We should not only avoid setting our hopes on compulsive forms of stabilisation, for example a technocratic dominance of nature and society. We should also resist the temptation of 'subject swapping' (Heinrich 2007), that is, ascribing subject qualities and agency to some larger, quasi-divine power – be it the 'Fate', the 'Being', 'Nature' or 'Mother Earth' herself –, on which one can then seemingly rely, even if these larger powers impose sacrifices or even disasters and subsequently promise rebirth, as origin powers do. From evolutionary theory, anthropology, psychoanalysis, complex system analysis and rich historical experience, we know that these forms of thought will never work, because, according to Freud, the repressed always returns, eventually in an even more devastating form. Only by substantially addressing conflicts, rather than repressing them, will we have the means to develop a perspective that is adequate to address our predicament in the Anthropocene.

5. Toward a new knowledge economy

In ancient urban societies, the evolution of knowledge as an aspect of cultural evolution gave rise to science that has – since the so-called Scientific Revolution of early modernity – turned from a marginal activity into an essential prerequisite of cultural evolution. Just as cultural evolution eventually developed from a marginal aspect of biological evolution into an evolutionary process in its own right, the growing integration of science into economic practices has given rise to new dynamics with planetary consequences, particularly since the use of fossil fuels in the Industrial Revolution.

The combination of economic, technological and scientific developments may be characterised as an even further accelerated and novel form of cultural evolution: as an 'epistemic evolution'. Just as biological evolution has been shaped – at least since the Neolithic Revolution – by cultural

evolution, cultural evolution is becoming ever more dependent on science and technology in an accelerated process that is driven by feedback loops between the material economy and the economy of knowledge.

The natural and the human sciences have been catalysts of the self-accelerating dynamics of cultural and epistemic evolution. But how can they be part of the self-analytic process of our species as well? This is ultimately the question of whether or not we can extract ourselves from these destructive dynamics that risk crossing planetary boundaries. How can the sciences contribute to the critical knowledge needed to engender the necessary transformation processes? Given that we are now dealing with a coupled human-Earth or rather techno-Earth system, it will not suffice to simply include scientific insights into the new narratives of the Anthropocene or to strengthen the pluralism of the many perspectives characteristic of human cultural evolution.

What, in my view, we need instead is a new operating system or, to put it differently, a new societal knowledge economy for generating, sharing and implementing relevant knowledge. This new knowledge economy should help to bring the riches of this pluralism to bear on the array of current challenges by integrating knowledge within and outside of academia, by strengthening the relationship between natural and social sciences and the humanities and by encouraging alliances between the sciences and the arts, thus mobilising their resistance power against the totalising dynamics of the technosphere. We need more system thinking, but we need also more transformation and orientation knowledge that allow us to realistically assess our situation and act accordingly. In a recent joint paper with Dirk, we explored these ideas with regard to the critical role of the interface between science and society for a sustainable future (Messner & Renn, forthcoming 2021).

6. The technosphere as a challenging object of geoanthropology

One important step on the way to such a new knowledge economy is to integrate the insights of the sciences and the humanities in the understanding of the Anthropocene. The technosphere is a new Earth sphere, but it is also a product of evolution, firstly of biological evolution, then of cultural and epistemic evolution. Like the biosphere, the technosphere represents a borderline problem to which fundamentally different perspectives apply, in particular those of Earth system science and those rooted in evolutionary theory. Such borderline problems have often been the starting point of major conceptual upheavals or even scientific revolutions,

as when borderline problems within classical physics engendered the revolutions of modern physics or when borderline problems between biology and natural history triggered the Darwinian synthesis.[3] The diagram illustrates the co-evolutionary dynamics of the techno-Earth system with the technosphere that has emerged from human niche construction and now represents a novel Earth sphere on a par with other Earth spheres.

I believe that we need a new transdisciplinary, transformative science in order to understand the techno-Earth system from an integrative perspective. Just as biogeochemistry studies the biosphere as a borderline problem of chemistry, biology and the synthesising qualities of the Earth system sciences, this new science of 'geoanthropology' should study the technosphere as part of the techno-Earth system by integrating different disciplinary perspectives.

Geoanthropology responds to the challenge of reorienting research to a systemic understanding of the technosphere by merging an updated version of Earth system research (the 'geo' including the 'bio') with cultural theories and histories of socio-material, energetic and informational flows (the 'Anthropos') to form a new discipline (the 'logos'). Cast into a research framework that studies the complex co-evolution of natural and human systems, geoanthropology aims to investigate the concrete human-created conditions of ongoing Earth system and biosphere destabilisation, the limits of socioecological carrying capacities, possible system thresholds and collapses, tipping elements and points of no return, and necessary socio-economic and cultural reaction times.

Finally, against this background, I want to come back to the task of defining the technosphere, not as a result of coarse-graining, which essentially reduces it to an object of physics, but as a borderline problem of the various disciplinary perspectives concerned with the multiple dynamics to which it is subjected – and thus as the challenging object of the new science of geoanthropology. Following the illuminating example of Peter Haff, I will formulate six rules that are intended to bring out these multiple dynamics:

1) The rule of the spheres: The technosphere is an Earth sphere in its own right and has global material and energetic dimensions comparable to those of other Earth system spheres.

3 For historical discussion, see Renn (2020: 124–127).

2) The rule of entanglement: The technosphere is entangled with other Earth spheres, shaping the dynamics of a composite techno-Earth system.
3) The rule of cultural evolution: The technosphere is subject to an interplay of niche construction and cultural evolution.
4) The rule of co-evolution: The evolution of the technosphere and the evolution of the biosphere condition each other.
5) The rule of expansion: The expansive dynamics of the technosphere as an evolving complex regulatory system with virtually unlimited energy resources risk to destabilise the techno-Earth system by transgressing planetary boundaries.
6) The rule of epistemic evolution: The technosphere is subject to an interplay of global changes and knowledge evolution involving an ever-greater dependence of human societies on science and technology, a dependence which contributes to its accelerated expansion but is also potentially capable of ensuring favourable conditions for the flourishing of human cultures.

The first rule defines the technosphere as a separate Earth sphere, without pretending to be a homeostatically stable system; the other five rules specify different types of dynamics that shape its evolution as a hybrid human/non-human system. The second rule states that the technosphere is subject to an overall Earth system dynamics, for example to continued human-induced climate change that may drive the system into a hothouse state or otherwise lead to the crossing of planetary boundaries. The third rule describes the continued dependency of the technosphere on the dynamics of cultural evolution, which involves niche construction as well as the cultural, social and economic changes interacting with it.

The fourth rule stresses the interaction between technosphere and biosphere in the sense that humans, their domesticated plants and animals, their ecologies, microbiomes, diseases and so forth are, at once, components of both the technosphere and the biosphere and are thus still subject to the biosphere's laws and evolutionary dynamics. The fifth rule addresses the expansive tendencies of the technosphere. These tendencies are due to various mechanisms, such as the feedback loops inherent in cultural evolution, population growth and access to virtually unlimited energy resources, first by tapping into fossil fuels, then by using nuclear and renewable energies. The sixth rule stresses the importance of knowledge evolution for the dynamics of the technosphere. It specifies the deeply ambivalent role of knowledge as a catalyst of its expansion and as a potential for mitigating and controlling its dynamics. Epistemic evolution may even

present the possibility of a veritable metamorphosis of the technosphere into an ergosphere in which humans can still recognise themselves.

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