The agency of technology and humans in the Anthropocene

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Du bist doch nur für uns bemüht
Mit deinen Dämmen, deinen Buhnen;
Denn du bereitest schon Neptunen,
Dem Wasserteufel, großen Schmaus.
In jeder Art seid ihr verloren;—
Die Elemente sind mit uns verschworen,
Und auf Vernichtung läuft's hinaus.

— Goethe, *Faust*

We got to install microwave ovens
Custom kitchen deliveries
We got to move these refrigerators
We got to move these color TVs

— Dire Straits, *Money for Nothing*

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Preface

Living in the Anthropocene is no small feat. We constantly face the consequences of a changing Earth: droughts, floods, heat waves, wildfires. This new world may be to our making—at least so it seems, as this appearance is what I thematise in my thesis—but it is not to our liking. The foundations to our liberal democracies are shaken, as climate change poses us with great challenges: the rise of post-truth politics that deny human impacts to climate change, as well as the rise of nationalist politics in response to climate refugees.

At the same time, many people do seem aware of the challenges, and try their best to mitigate the effects of climate change. Although always well-intentioned, I sometimes wonder if their efforts are directed at the right problems. Are we really tackling the roots of the problem, or do we merely engage in symptom management? In this thesis I question some of the common-sense views we hold on climate change and technology. I hope that with this, I can shed some new light on the challenges of the Anthropocene, so that we can see more clearly the road we need to follow.

Writing on this topic was depressing at times, since our current outlooks are not bright. If we extrapolate the current trajectory of the Earth system, we are heading straight towards a catastrophe.

Fortunately, my process of writing this thesis wasn't a catastrophe—but only so because of the tremendous support I received from the people around me. First of all I would like to thank my supervisor, Pieter Lemmens. We have discussed my drafts countless times, and I always received valuable feedback to guide me further. Our conversations were ever interesting and you consistently pointed me towards new sources, new angles to consider—up until the very end.

Next to my supervisor, I would like to thank my lecturers, who have inspired me and helped me discover the treasure of philosophical sources that our tradition is blessed with. In particular I would like to thank Paul Ziche, Sander Werkhoven, Niels van Miltenburg, and Rob van Gerwen, the teachers of my philosophy minor in Utrecht, who have ignited my passion for philosophy. And I would like to thank Boris van Meurs, who has provided me with all the tools I needed for writing this thesis—from note taking strategies to structuring arguments. Without your help, I would have been at a complete loss writing this text. In addition, Boris has introduced me to the world of the Anthropocene and to the work of Peter Haff in particular, one of my main authors. Similarly I would like to thank Nolen Gertz, who introduced me to the writings of Jacques Ellul, the other main author for my thesis.

I am also very grateful to the environment in Nijmegen in which I wrote the lion's share of my thesis. I combined my writing with jobs at Radboud Reflects and at the communications department of Radboud University. I was always happy to work with my colleagues there, to direct my mind towards other things than my thesis alone. And you provided me with all the flexibility I needed when writing a thesis. A word of thanks also goes out to the editors and other contributors of the *Algemeen Nijmeegs Studentenblad*, with whom I spent many of my lunch breaks and with whom I often discussed the things I was writing on. Your company was what motivated me to go to campus each day.

When I needed some time off, my friends were always there for me. Both in Nijmegen and in Rome, where I completed writing my thesis, I thoroughly enjoyed the time I spent with you, be it at festivals, city trips, cooking workshops, guided tours, or dinner nights.

During the course of writing, Nelleke and I met each other. With you in my life, I am happier than I have ever been. I reckon it must have been challenging for you, with so much of my time dedicated to studying and working. Even more so because I spent the last semester abroad. I want to thank you for your patience and the support you have always given to me.

Finally I want to thank my parents for all their love and support. My academic career has been highly atypical; as an 'afvallige ingenieur', I ended up studying philosophy, ticking off the boxes of *alpha*, *bèta* and *gamma* studies along the way. Although perhaps hesitant as first, you have always supported me in doing the things that bring me the most joy, even if that meant going off the beaten track. I feel blessed having you as my parents. Without you, I would never be where I am today.

The agency of technology and humans in the Anthropocene

CHAPTER 1
Introduction

> *If names be not correct, language is not in accordance with the truth of things. If language be not in accordance with the truth of things, affairs cannot be carried on to success.*
>
> — Confucius[1]

Eindhoven University of Technology: *Where innovation starts*. University of Twente: *High tech, human touch*. Delft University of Technology: *Impact for a better society*. A quick glance over the promotional slogans from Dutch universities of technology reveals that these institutions have a firm belief in the power of technological innovation for improving the human condition. The designers of high-tech systems promise us that technology is the prime, if not the only way of solving the problems that humanity faces. In doing so, they often refer to the Sustainable Development Goals, as drafted by the United Nations.[2] With technology, they believe, we can tackle all kinds of problems, ranging from poverty and hunger to gender inequality and pollution. In particular, technology can be leveraged to combat climate change and to make the switch to sustainable ways of living. This way of thinking, in which all complex situations are recast as neatly defined problems that can be solved with technology, is

1. Confucius, *The Analects*, bk. 13, ch. 3.

2. See United Nations, *Sustainable Development Goals 2016*. Universities often make explicit links between their research areas and the sustainable development goals. Examples for Eindhoven (https://www.tue.nl/en/our-university/about-the-university/sustainability/sustainable-development-goals-sdg/) and Wageningen (https://www.wur.nl/en/research-results/sustainable-development-goals.htm).

often called *solutionism*.[3]

As a schooled engineer, I experienced first-hand how engineering education is drenched in techno-optimism. No problem was too big; given the right knowledge and tools, engineers can solve all problems humanity faces. The implicit assumption underlying all this is that technology has no intrinsic moral value; it is not inherently good *or* bad. Under said assumption, technology is a neutral tool to attain societal objectives, preferably in the most efficient way possible. This common-sense position is known as *instrumentalism*.[4] Engineers are often instrumentalists, although they may not know it.

The attraction of such a position is that it entails that technology put in the right hands can—and will—do good. For instance: technology can be used to mitigate the effects of climate change. In 2022, Robert-Jan Smits, president of the executive board of Eindhoven University of Technology, called for funding from the central government in order to facilitate the growth of the university. When asked why this growth was needed, Smits replied: 'Because of the transitions in climate, energy and nitrogen, our society is desperate for system engineers. These are huge challenges that require engineers.'[5] This is a solutionist way of thinking: climate change is a complex problem but we can solve it by means of technology.

And the challenges are huge indeed. The changes to the functioning of our Earth system are so immense and sudden—at least on the geological time scale of the Earth—that some geologists have proposed that the Earth has progressed from the Holocene into a new geological epoch: the *Anthropocene*.[6] It is named after us humans (ἄνθρωπος in Greek), because it is humans that have brought about the changes to the functioning of the Earth system.[7]

3. E.g. Morozov, *To Save Everything, Click Here*, 5–6.

4. Definition after Swierstra et al., *Technical Condition*, 21.

5. Persteam TU/e and Konings, 'TU/e Prepared to Grow, Under Certain Conditions'.

6. The term was popularised in Crutzen, 'Geology of Mankind'.

7. But the term is controversial too. As of May 2023, the International Commission on Stratigraphy has not formally recognised the epoch of the Anthropocene as the successor of the Holocene ('Anthropocene' is missing in the official chronostratigraphic chart in Cohen et al., 'The ICS International Chronostratigraphic Chart'). Furthermore, Langdon Winner has criticised the term 'Anthropocene' on the grounds that it is too anthropocentric and it presents the human species as a unified whole; see Winner, 'Rebranding the Anthropocene'. I agree that presenting the human species as a unified whole

The solutionist line of reasoning only works if technology is *indeed* capable of tackling problems like climate change. And it is not so clear that it is. Over the past centuries, we have started using more and more carbon-intensive technologies. These are an important cause of the climate crisis we find ourselves in. One might say that back in the day, when we started using these technologies, we were not aware of their devastating effects. This is true; only in the last fifty years have we learned about the effects of carbon emissions on the functioning of our planet. One would expect that since then, we have taken action to mitigate these effects. *This has not happened.* A striking way of showing this is by plotting large climate conferences alongside the CO_2 concentration and average temperature on Earth, as is done in in figure 1.1. Political milestones on climate policy do not change the Earth's course; it seems as if humans are powerless in their attempts to counteract anthropogenic impacts.

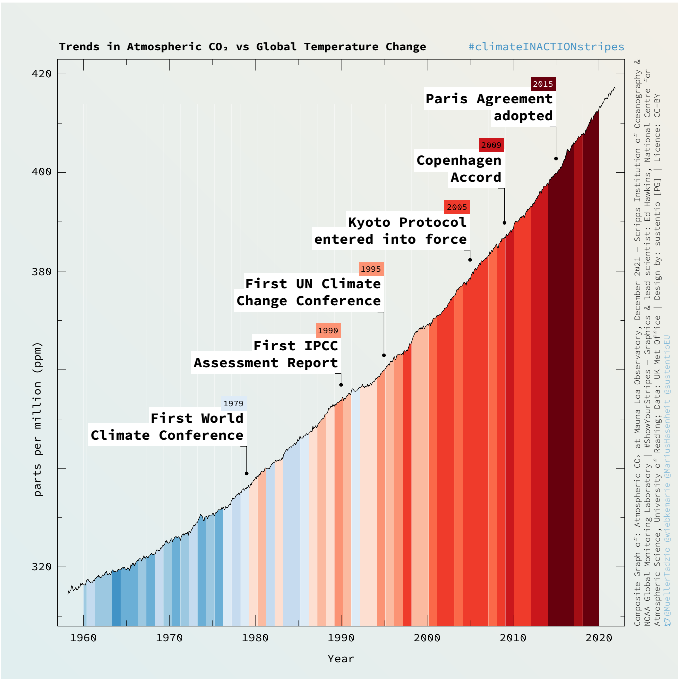

FIGURE 1.1 Atmospheric CO_2 concentration (*y* axis) and deviation of global temperature from the average (colour) over time (*x* axis), along with some climate conference milestones.[8]

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is misleading, because the majority of human beings have had a negligible impact on the Earth systems. But I think this is beside the point, because the changes to the Earth system *are* largely anthropogenic (i.e., caused by human activity), and the term 'Anthropocene' reflects this adequately.

We can summarise our predicament as follows: we know that our actions are causing climate change, but despite our best intentions, we seem unable to fix things. The Austrian philosopher and cultural theorist Erich Hörl poses our situation as a contrast between human agency and environmental agencies. He formulates this *Anthropocene illusion* as follows:

> [The] explosion of environmental agencies (…) ends up relegating the human being as agent and demonstrates the illusionary character of what lies behind the human technological achievement, namely, the illusionary character of the monopoly on agency in general, and of the privileging of human agency in particular.[9]

Evidently, humans are not the only source of agency on Earth to be reckoned with. In fact, the technologies that *we* have created have agency on their own, as I will demonstrate later in this thesis. They function according to their own goals, that may or may not coincide with our human goals.

Instrumentalism cannot deal with this illusion. After all, if technologies were merely neutral tools, they could hardly have agency on their own. At best, they augment the agency of the person wielding the tool. If, on the other hand, we recognise the existence of agencies other than our own, we may get a more complete picture of the forces at play in the Earth system.

In this thesis, I investigate the ever-increasing agency of technology, and assess to what extent humans are able to influence technology. This leads me to the following research question:

> Considering that in the age of the Anthropocene, technology has become a planetary phenomenon, what does it mean to say that technology has agency of its own, how does this agency operate in relation to human agency, and consequently, what is left of human agency if technology indeed possesses some kind of autonomy?

Finding an answer to this question is relevant, because *human responsibility presup-*

8. Sustentio, '#climateINACTIONstripes. Virale Klimakommunikation'.

9. Hörl, 'Ecologization of Thinking', 12–13.

poses response-ability.[10] Many authors point to the need for us to take responsibility. For instance, in his *Defiant Earth*, the Australian author Clive Hamilton likes to stress that humans need to take more responsibility to care for our Earth.[11] He calls humans super-agents and points to technology as the cause of our super-agency. For him, our failure to respond to the evidence of the destabilisation of the Earth system is wanton neglect. We *chose* the path of neglect, and that very choice affirms our capacity to act differently.[12]

What I try to show in this thesis is that an appeal to human responsibility is not straightforward. The Anthropocene illusion casts doubt on our ability to 'take back control' over our planet. Or perhaps that is an imprecise way of putting it, as it is not clear that we ever had it in the first place. If our human super-agency is indeed challenged by other (super-)agents, how can we maintain that it is solely *our* responsibility to take good care of the Earth? And if human agency is increasingly being overshadowed by technological and environmental agencies, one may wonder if humans even have the *capacity* to re-stabilise the Earth system.

My goal, then, is to find a conception of technology that can deal with the Anthropocene illusion. Naturally, this will be a non-instrumentalist conception, as it is clear that instrumentalism still wrongly clings to the human monopoly on agency. I do not wish to claim that the conception I put forward is the only correct way of understanding technology. Instead I propose to consider it as a narrative, a story of the Anthropocene.[13] Narratives always single out certain elements and obscure others; my story is no different. But I do hope that it will bring about an effect in the reader, allowing them to gain a fresh outlook on the Anthropocene.

To construct my narrative of the Anthropocene, I turn to the works of two authors: Jacques Ellul and Peter Haff. Jacques Ellul is a classical philosopher of technology who has written extensively on the autonomy of technology. His works, in particular *The Technological Society*, allow us to better understand the Anthropocene

10. The term 'response-ability' is borrowed from Donna Haraway, although earlier uses of the term can be found. See Haraway, *When Species Meet*, 88.

11. E.g. Hamilton, *Defiant Earth*, 43: 'we now have a responsibility for the Earth as a whole and pretending otherwise is itself irresponsible'.

12. Hamilton, 133, 151–53.

13. Bruno Latour has coined the term 'geostories' for narratives on the Earth; see Latour, 'Agency Anthropocene', 3.

illusion: how it is possible that we *feel* we are in control of technology, whereas in reality, it is technology that controls us. With this statement, Ellul can be considered a technological *autonomist* and *determinist*: technology follows its own internal logic and humans have little influence in changing its course. Needless to say, Ellul is critical of the instrumentalist position.

Whereas Ellul approaches technology mainly from a societal standpoint, geologist Peter Haff attempts to put Ellul's autonomy of technology on a more physical basis. His concept of the *technosphere* revitalises technological determinism in the era of the Anthropocene. Ellul did not thematise technology from a planetary standpoint—understandably so, as the Anthropocene only gained traction in the philosophical debate long after Ellul passed away—but Haff does.

A critical comparison of these authors, leading to a possible synthesis, is fruitful. Ellul provides the philosophical depth that may be lacking in Haff's writings, whereas Haff deals more directly with the challenges of the Anthropocene. I compare the works of Ellul and Haff, criticise them, and eventually use their synthesised joint conception of technology to answer the question on agency of technology and humans in the Anthropocene.[14] In what follows, I will explain the advent of the Anthropocene, as well as Haff's and Ellul's theories, gradually building up to a discussion on agency in the Anthropocene.

14. One note on the scope of my project is in place. Ellul and Haff have written on the agency of technology, but also on the effects of the technological lifeworld on our individual psyche. Important as it may be, I do not address this latter issue in this thesis.

CHAPTER 2
From Holocene stability to Anthropocene rupture

> *Upon what planet do today's philosophers of technology think they are living?*
>
> — Langdon Winner[1]

You may ask yourself: 'Well, how did we get here?' In this chapter I sketch out the history of the Anthropocene. I will relate the advent of the Anthropocene to the project of modernity, paying special attention to the role of technology. I will then establish the transition to the Anthropocene as a *rupture* and explain the role of agency in this.

2.1 The original promise of technology: emancipation from nature

We can understand the project of modernity as a project of distancing oneself from nature, of dominating nature, of transcending the inherently unpredictable world around us. In other words: the project of modernity holds the promise of emancipating man from nature.[2] Along with Descartes and Newton, the English philosopher Francis Bacon is one of the initiators of this project. He famously held that knowledge is power, specifically power over nature: 'Now the dominion of man over nature rests only on knowledge.'[3] Bacon's goal is to free humans from the limitations that nature

1. Winner, 'Future Philosophy of Technology'.
2. E.g. Bonneuil, 'Geological Turn', 24.
3. Bacon, 'On the Idols', 35.

imposes:

> The end of our foundation is (…) the enlarging of the bounds of human empire, to the effecting of all things possible.[4]

How is this power over nature to be obtained? Using technology, of course. In *New Atlantis*, Bacon imagines a future in which technology—the application of scientific insights—brings humanity health, prosperity and power. That, according to American historian Lewis Mumford, is what sets Bacon apart from other geniuses of his time. Whereas scientists like Galileo and Kepler were mostly concerned with understanding the physics of the celestial universe, Bacon managed to bring science down to Earth, by declaring 'the relief of man's estate' the ultimate goal of science.[5] This understanding of science entails not just the pursuit of knowledge for its own sake, as Aristotle had it; it is very much connected to people's worldly desires. Technology is our means to push the boundaries of human ability.

An implicit assumption of modernity is that nature serves as a stable background. This assumption is present to this very day, as the American philosopher of technology Langdon Winner points out: 'much of philosophical thinking still quietly presupposes and leaves unquestioned basic underlying conditions of that have served as foundations for the rise and continuation of modern industrial societies.'[6] Among the underlying conditions that Winner mentions, is the existence of a stable, favourable climate.[7] Based on this condition, modernity was able to flourish. The modernists could regard nature as something external and purposeless, using the world as resource for building our present-day societies.

2.2 Entanglement: nature bites back

In the Holocene, the assumption of nature as a stable background was more or less warranted. Hamilton even calls the Holocene a '10-millennium epoch of calm'.[8] At the end of this epoch, technology has somewhat achieved the aims that Bacon first

4. Bacon, *New Atlantis*.
5. Mumford, *Myth of Machine 2*, 106.
6. Winner, 'Future Philosophy of Technology'.
7. Winner.
8. Hamilton, 'Earth Juts Through World', 1.

formulated—health, prosperity, and power. Life expectancy has skyrocketed over the past centuries.[9] We generally live longer and in better health. The standard of living has increased tremendously, too. With the help of industrial mass production, products which used to be luxury items for the happy few are now available to a vast proportion of the population. An example is the mass produced Ford Model T automobile, which made cars affordable for the middle- and working classes. Our power over nature is also spectacular. Just take a look at the Dutch landscape. A large part of the Netherlands lies below sea level, protected by technological structures such as dykes and dams.

But in the Anthropocene, something strange has started to happen. Nature now increasingly acts in ways that are hard to predict. Nature manifests itself more clearly than ever.[10] It seems that our technological interventions in nature have unintended consequences. These are not caused by a single technology, but rather by the complex of technologies. In response to these technologies, *nature bites back*, to speak figuratively. 'Modern technology, which promised to emancipate humanity from nature,' writes Pieter Lemmens, 'now threatens to destroy it and thereby to annihilate the ultimate condition of human life as such.'[11] We can call this act of biting back an expression of *entanglement*: the technological civilisation has become intermingled with ecological systems and even the Earth system as a whole.

The clearest and best-known example of nature biting back is the phenomenon of global warming. Due to anthropogenic impacts, that is, impacts originating in human activity, the average global temperature is rising. The evidence of human influence on the Earth is compelling. Climate scientist Will Steffen and his colleagues write that the 'human imprint on the global environment has now become so large and active that it rivals some of the great forces of Nature in its impact on the functioning of the Earth system.'[12] Relevant anthropogenic impacts include the emissions of CO_2 and other greenhouse gasses into the atmosphere. These impacts are endangering the survival of humans on Earth.

9. E.g. Roser, Ortiz-Ospina, and Ritchie, 'Life Expectancy'.
10. Cf. Stengers, 'Autonomy and Gaia'.
11. Lemmens, 'Entanglement Technology and Nature', 203.
12. Steffen et al., 'The Anthropocene', 842.

2.2.1 Anthropocene as rupture

We can understand transitions from one geological epoch to another either as the result of a gradual evolution of natural forces, or as that of a catastrophic event: a *rupture*.[13] In this section, I argue alongside Clive Hamilton that the transition from Holocene to Anthropocene is an instance of the latter: a radical break with our Holocene past.[14]

In order to assess whether a transition counts as evolution or rupture, we need to consult Earth system science (ESS). ESS provides us with Earth system *indicators* that track global climate. These indicators include average surface temperature, the atmospheric concentrations of carbon dioxide, nitrous oxide, and methane, ocean acidification, tropical forest loss, and percentage of domesticated land. Before the 1950s, geological evidence for a large-scale shift in the functioning of the Earth system was still weak. However, Steffen et al. argue that since the 'Great Acceleration', which happened after World War II, the indicators reveal that the Earth system is functioning differently now than it did in the Holocene.[15] All of these indicators have been rising sharply since the 1950s, supporting Hamilton's rupture narrative.[16] Moreover, the rate of change is far higher than it ever was in the history of the Earth—hence the name 'Great Acceleration'. We can conclude that, in the Anthropocene, the Earth system functions differently than it did in the Holocene.

2.3 Technology and rebound effects

Steffen and colleagues argue that the Anthropocene rupture, as observed with the Earth system indicators, is clearly driven by the impact of human activities.[17] Hamilton similarly writes that 'the wanton use of our (…) technological power

13. Hamilton, *Defiant Earth*, 5.

14. Hamilton, 'Theodicy of "Good Anthropocene"', 237; Hamilton, *Defiant Earth*, 1–5.

15. Steffen et al., 'Great Acceleration', 82, 93.

16. With the exception of surface temperature, the Earth system indicators do not directly track climate change. Still the relationship between concentrations of greenhouse gasses and global temperature is well-established beyond reasonable doubt, as is the relationship between ocean acidification and global temperature. See IPCC, 'Summary for Policymakers', 4 (A.1.2); Steffen et al., 'Great Acceleration', 89.

17. Steffen et al., 'Great Acceleration', 82.

[has] led us to the brink of ruin.'[18] I propose to modify their formulation, as I take issue with calling technological power 'ours'. This implies that it is us humans wielding the technological power. While it is true that humans have set the technologies in motion—we designed and manufactured them—, it is not necessarily the case that humans are still in charge of these technological processes. Hamilton's formulation is prone to an instrumentalist reading in which humans *are* in charge. As I already demonstrated in the introduction, instrumentalism does a poor job at dealing with the Anthropocene illusion. So I propose instead that the Anthropocene rupture is driven by *technological* activities, of which humans are a part—our embeddedness in these activities by no means implies that we are the ones controlling them.

An example may clarify my point. Many of our human activities involving technologies are aimed at improving sustainability, as seen in the optimistic slogans of the universities in the introduction. In a way, these activities are successful. Techno-optimists like to point out that technological innovations have made our consumption more sustainable. In a narrow sense they are right; emissions per unit of consumption have indeed decreased. We can see this in figure 2.1, which shows the steady fall of global emissions per unit GDP in the last few decades. For the same amount of consumption, we now emit fewer greenhouse gasses.

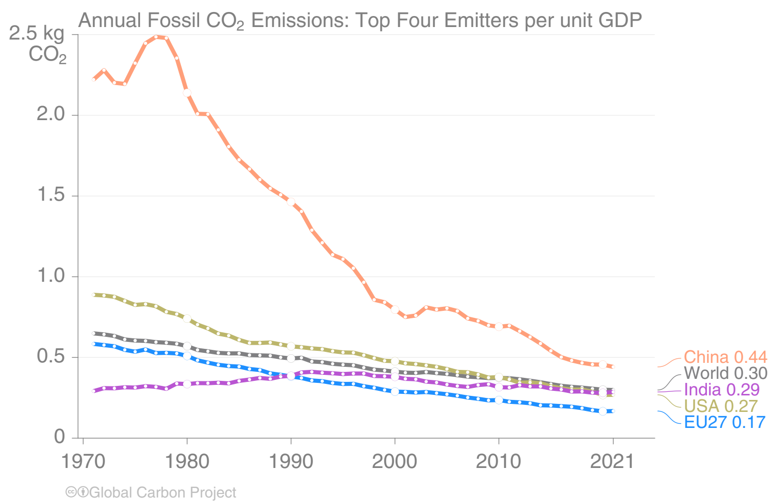

FIGURE 2.1 Annual fossil CO_2 emissions per unit GDP for the top four emitters and for the world.[19]

18. Hamilton, *Defiant Earth*, 37.

What the optimists overlook, however, is that consumption has *not* remained constant. On the contrary; consumption per capita has skyrocketed the past decades, so much so that the negative effects of technological innovation on energy intensity are completely negated by this positive effect. Another factor that increases our energy use is the growth of the global population. These factors together explain why in figure 1.1, CO_2 emissions have been constantly on the rise, despite the decrease in emissions per unit of consumption.[20]

The effect we see here is known as the *rebound effect*: the increase in efficiency of some technology leads to a cost decrease of using that technology. Because of decreased cost, more consumption is promoted.[21]

A special case of the rebound effect is the Jevons paradox. In this situation, the consumption increase is larger than the efficiency increase, leading to a backfire effect where efficiency improvements are completely negated. It was first observed by English economist William Stanley Jevons, who found that the increased efficiency of coal use resulted in an increased consumption of coal.[22] We find a contemporary example in the LED lighting revolution, which has made lighting much more affordable, resulting in higher consumption of light, thus offsetting any net efficiency gains.[23] There is empirical support for the Jevons paradox on a macro level.[24]

The Jevons paradox is of particular significance in the climate crisis, because it raises questions about the efficacy of the climate policies being enforced. We see that, despite our best intentions, emissions are increasing. If improvements to the energy efficiency of our means of production lead to more consumption, to the point of neg-

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19. Friedlingstein et al., 'Global Carbon Budget 2022'.

20. A powerful way of analysing these effects is by decomposing global emissions into its contributing factors: carbon intensity, energy intensity, consumption (GDP), and world population size. We can use the *Kaya identity* for this, a mathematical tool developed by the ESS field, explained in some detail in appendix A.1.

21. See Polimeni and Polimeni, 'Jevons' Paradox', 352. Naturally, we should be careful to conclude that increased efficiency *causes* increased consumption. The rebound effect shows correlation, not causation.

22. See Jevons, *Coal Question*. In situations where the rebound consumption is smaller than the expected savings, there is partial rebound effect. See appendix A.2 for a mathematical definition of the rebound effect, along with an overview of all five classes of rebound effect.

23. Fouquet and Pearson, 'Seven Centuries of Energy Services'.

24. Polimeni and Polimeni, 'Jevons' Paradox', 344.

ating the negative effect of these improvements on global emissions, one may wonder if our climate strategy is right.

2.4 Agencies in the Anthropocene

So far, we have seen that our modernist way of thinking has paved the way for the Anthropocene rupture, and that technologies act in ways that are not (entirely) under human control—that is, technologies have agency on their own. In order to clear up the discussion that follows, it serves us well to investigate how our modernist thinking led us to turn a blind eye to the explosion of agencies on Earth.

In modernity, agency was only attributed to humans. This is a result of the the dualism between the subject and object (Descartes), or between the realm of necessity and the realm of freedom (Kant). By distinguishing the phenomenal world of causality from the noumenal world of freedom, it became commonplace to draw a strict line between a necessary, inanimate nature devoid of agency on the one hand, and free, animate, agency-possessing humans on the other: the modernist distinction between nature and society. The science historian Christophe Bonneuil calls this a story of *human exemptionalism*,[25] in which technology sets us free from nature's limits—an echo of Bacon's project.

This strict dualism is reflected in the standard (western) conception of agency, which construes action in terms of *intentionality*. An act is intentional if it is performed for a reason.[26] Only beings that have the capacity to act intentionally can exercise agency. Under this definition, agency is the privilege of human consciousness,[27] since human minds are the only things that can act for reasons.[28]

However, in recent decades this standard conception of agency has come under attack. Bruno Latour argues that the entanglement of humans, technology and nature has made the standard conception of agency problematic. The Anthropocene reveals we can no longer make a strict distinction between inert objects without intention-

25. Bonneuil, 'Geological Turn', 17.

26. See e.g. Schlosser, 'Agency', sec. 2.

27. Kim, 'Nonhuman Agency in Anthropocene', 9.

28. We might extend the definition somewhat by also including some so-called 'intelligent' animals, but there is no way that modernists could extend it to 'merely material' beings such as computers or, relevant for my discussion, geological or technological systems.

ality and living things with intentionality. Latour has argued that we have *never* been modern in our approach to nature. The modernist split between nature and culture that we find with Bacon and Descartes, is absent in premodern times.[29] Latour emphasises the proliferation of hybrids, which do not conform to the modernist split between nature and culture. An example is the recent Covid-19 pandemic, which was caused by a combination of natural and cultural factors. Although the Earth is a unitary system, it consists of many agents that constantly act upon each other and may have conflicting goals.[30]

In the remainder of my thesis, I employ a Latourian definition of agency. I define agency not as a property of individual human beings, but rather as a property of collective 'actants', that is, 'humans and nonhumans related to each other in specific, systematic ways'.[31] Agency, then, is the capacity of these actants to *act* in order to obtain a certain *goal*.[32] In chapters 4 and 5, I will detail how we should understand technology as having agency of its own. But first, in the next chapter, I will look at different possible responses to the rupture of the Anthropocene, arguing that a response recognising the agency of technology may be most successful.

29. Latour, *We Have Never Been Modern*; Latour, 'Agency Anthropocene', 15.

30. Lemmens, 'Entanglement Technology and Nature', 218.

31. Preston, 'Artifact', sec. 3.3.

32. Cf. Latour, 'Agency Anthropocene': 'To have goals is one essential part of what it is to be an agent' (10) and 'For all agents, acting means having their existence (...) come from the future to the present' (12).

CHAPTER 3

Responses to the Anthropocene rupture

Technology is neither good nor bad; nor is it neutral.

— Melvin Kranzberg[1]

How are we to respond, both philosophically and practically, to the rupture of the Anthropocene? In this chapter, I will first evaluate and reject two responses that differ in their appraisal of technology: embracing technology as the solution to our problems, and rejecting technology altogether. I will conclude that both responses cling to a modernist distinction between nature and society/technology, whereas what we need is a *re-interpretation* of technology. I will put forward technological determinism as a viable alternative to these responses, because it provides such a re-interpretation. Whereas the first two responses see technology as largely under human control, with all the associated drawbacks we saw in the previous chapters, determinism grants agency to technology, thereby bypassing these drawbacks. I will argue that Ellul and Haff are suitable thinkers to address the challenges of technology in the Anthropocene, although we should also qualify and refine their ideas of technological determinism.

A good response to the Anthropocene rupture should satisfy a set of desiderata. Specifically, it should (1) agree with the empirical findings of ESS, (2) not be instrumentalist, and (3) overcome the modernist dualism between nature and society. Desideratum (1) is necessary, as the response should be compatible with the Earth sys-

1. Kranzberg, 'Technology and History', 545.

tem indicators showing that the Earth is now behaving differently than it did before the industrial revolution.[2] In other words, I take Hamilton's rupture narrative as convincing, and a good response should not downplay this rupture of the Anthropocene. Desideratum (2) is necessary in order to deal with the Jevons paradox we saw in the previous chapter. Desideratum (3) is necessary because entanglement makes this distinction untenable. In what follows, I will judge the responses on these desiderata.

3.1 The ecomodernist response: pretend nothing substantial has changed

We have seen that Earth system's functioning is changing. Does this necessarily mean we should worry? The *ecomodernists* do not think so, because humans have modified ecosystems for ages. American ecomodernist Erle Ellis emphasises the continuation of human intervention in nature.[3] From the moment humans invented agriculture, and arguably before that, they have reshaped the terrestrial biosphere to better fit their needs. The Anthropocene is not radically different from these earlier interventions.

Ellis argues that it is not planetary boundaries, but human system boundaries which held back the development of humankind in the Holocene era.[4] The Anthropocene is not a threat but an opportunity for humans to increase their power over the planet, in order to create a better planet for both humans and nonhumans.[5] In their manifesto, the ecomodernists state that, if we aim our powers in the right direction, we can create a 'good Anthropocene'.[6]

Central to the position of the ecomodernists is the attempt *decouple* human development from environmental impacts.[7] This means they aim to reduce anthropogenic effects on the Earth system. Cities are taken as a prime example of successful

2. Note that accepting the empirical findings of ESS does not mean we also need to accept the claims by ESS that science is the answer to 'lead humanity towards a sustainable future' (characterisation as formulated by Bonneuil, 'Geological Turn', 18).

3. Ellis, 'Planet of No Return', 38–40.

4. Ellis, 37–38.

5. Ellis, 38.

6. Asafu-Adjaye et al., 'Ecomodernist Manifesto', 7.

7. Asafu-Adjaye et al., 7, 11.

decoupling, as they occupy only a small amount of Earth surface, yet provide housing for over half the world's population. Furthermore, ecomodernists predict that in the long term, the world population size will decrease and economies will become materially less intensive. This will eventually lead to a decline of human impact on the Earth system.[8]

In order to facilitate decoupling, ecomodernists resort to technology, often called the 'technofix'. Many of these technologies are forms of *geoengineering*: the deliberate manipulation of the environment in order to counteract anthropogenic climate change.[9] An example of geoengineering is the delivery of a layer of sulphate aerosols in the atmosphere in order to reduce the amount of sunlight that reaches the planet surface, thereby cooling down the Earth.[10] Many (but not all[11]) ecomodernists support such efforts of geo-engineering.

3.1.1 Problematisation

Unfortunately, the ecomodernists' approach fails for multiple reasons. First, their call for decoupling implies a strict boundary between nature and society. But from the explosion of agencies in the Anthropocene, we know that such modernist duality is no longer tenable. Ecomodernists fail to recognise that we are unable to separate our human affairs from the Earth at large.

Secondly, ecomodernism builds upon a misreading of science. Ecomodernists see the Earth system as a collection of ecosystems. But ESS shows that the Earth system is *not* equal to a collection of ecosystems. While it is true that humans have modified their environment for millennia, these interventions in the biosphere have had a negligible effect on the Earth system as a whole. In the current situation, however, the anthropogenic effects on the Earth system are clearly visible in the data, as we saw earlier with the Earth system indicators (section 2.2.1). Ecomodernists unwittingly deflate the significance of the Anthropocene by posing it as a continuation

8. E.g. Asafu-Adjaye et al., 11–15.

9. Definition from Keith, 'Geoengineering Climate', 246.

10. E.g. Rasch et al., 'Geoengineering Using Stratospheric Sulphate Aerosols'.

11. In a recent lecture, Ellis said he is not an advocate for geo-engineering, but he does think it is a line of research we need to study. See Ellis, 'Anthropogenic Ecologies'.

of, instead of a radical break with, our Holocene past.[12] Posing the Anthropocene as a continuation is like setting someone's car on fire, then saying: 'Don't worry, your car's temperature has changed before.'[13]

Another problem with ecomodernism is its *instrumentalism* with respect to technology. We have seen that technology is a major factor contributing to the changes in the functioning of the Earth system. Ecomodernists turn to technology for solving the issues of climate change, while these largely *arise* from the use of technology. It is clear that technology has the power to intervene in the Earth system—the Anthropocene shows exactly that—but we also saw that intervention comes with unintended consequences, which may worsen the condition of the Earth. Because of its instrumentalist stance, ecomodernism is also unable to deal with the Jevons paradox.

3.2 The ecocatastrophist response: reject technology

On the other end of the spectrum, we find people who instead reject our technological achievements in different degrees. Bonneuil calls their narrative *ecocatastrophism*.[14] Ecocatastrophists argue that humans have transgressed planetary boundaries, and that we are at risk of passing Earth tipping points, which will lead to an unstable global climate. This transgression may lead to a collapse of civilisation.

We can find an early version of ecocatastrophism in the 1972 report *The Limits to Growth*, commissioned by the Club of Rome. In this report, the authors discuss the (im)possibility of exponential economic and population growth given a finite set of resources.[15] One of their main conclusions is that the present growth of population and production cannot continue for much longer, lest there shall be a collapse of human civilisation.[16]

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12. Hamilton, *Defiant Earth*, 14, 17, 25.

13. Example after Munroe, 'Earth Temperature Timeline'.

14. Bonneuil, 'Geological Turn', 26–27.

15. Meadows et al., *Limits to Growth*.

16. The present claim of ecocatastrophists is slightly different from the warning given in 1972. Whereas the report from the Club of Rome focussed on resource depletion, we now know that there are plenty of fossil fuels to heat up the Earth with more than 12 °C by 2300 (Collins and Knutti, 'Long-Term Climate Change', 1033). So the problem is not an exhaustion of resources, but rather the *flow* limits of the Earth system. The Earth has a limited capacity of biogeochemical processes, such as the carbon and nitrogen cycle, and human activities are accelerating these processes to intolerable levels (Bonneuil, 'Geological

To prevent collapse, ecocatastrophists suggest we strive for 'degrowth' of 'deindustrialisation'.[17] In their post-growth society, 'life would be based on a lower and simpler material and energetic base, but with more enjoyable, meaningful and egalitarian communities.'[18] For instance, American journalist Richard Heinberg argues that life in a non-growing economy may still be fulfilling, because there can be development in other fields, such as practical skills, artistic expression, and some kinds of technology.[19]

Unsurprisingly, ecocatastrophists reject the technofixes that ecomodernists propose. They believe that geoengineering approaches are hazardous, because interventions in the increasingly complex Earth system may lead to unintended consequences. We should instead focus on bottom-up, low-tech solutions to mitigate environmental problems.

3.2.1 Problematisation

Compared to the ecomodernists, the ecocatastrophists display a better understanding of the ESS findings. Ecocatastrophists rightly identify the advent of Anthropocene with rupture. With their rejection of the technofix, they also circumvent the ecomodernists' mistake of viewing technologies as neutral tools, thus avoiding the fallacy of instrumentalism.

However, Ecocatastrophism fails to fully overcome the modernist duality. Although ecocatastrophists criticise the project of modernity, they also underestimate the entanglement of nature and technology, albeit in a different way than ecomodernists.[20] Their suggestion to return to a simpler 'post-growth' lifestyle is illusory, because their idea of a pristine, pure nature is a fantasy.[21] The blunt fact is that we *do* live in a technology-dominated world. There is no way back. In the words of Hamilton: if there is one thing we can learn from the Anthropocene, it is that it is too late to

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Turn', 26–27).

17. Lemmens, 'Entanglement Technology and Nature', 216.

18. Bonneuil, 'Geological Turn', 27.

19. Heinberg, *End of Growth*, 57.

20. Lemmens, 'Entanglement Technology and Nature', 220.

21. The ecomodernists in fact recognise this. Erle Ellis writes that hopes to return to some pristine era before technology are nostalgic and unrealistic. See Ellis, 'Planet of No Return', 42–43.

abandon our anthropocentric viewpoint.[22]

Ecocatastrophists also fail to explain our inaction after learning about our anthropogenic impacts on the Earth system. As Dennis Meadows, one of the writers of the *Limits of Growth* report, said as early as 1974:

> No single politician in the world, no single political organisation, no party, no important industrial concern has changed its behaviour since the publication of *The Limits to Growth*. It is as though nothing had happened; as though we had hidden the study away in our desks: everything remained as before![23]

Ecocatastrophists might explain our inaction by saying that many people do not realise the gravity of the situation, that politicians are shortsighted, and that climate deniers spread misinformation to confuse the debate, for instance to appease the fossil fuel lobby. I think this response is correct, but it is not complete. After all, results are indeed being achieved in the green revolution and in the energy transition. More renewable energy is being generated than ever. The appliances we use are becoming ever more energy efficient. *And yet* these developments are not observable on a large scale: our energy consumption is still growing, as are greenhouse gas emissions. I believe that a better response is possible: by pointing out that technologies *themselves* have agency, with goals possibly conflicting with our own, we have an easier job of explaining our inaction .

Related to this last point, the ecocatastrophists' proposed solution of degrowth indeed seems to conflict with the goals of technology. As I will show in chapter 4, the technological system has a tendency to consume an ever increasing amount of energy. Degrowth goes against this tendency and is therefore hard to achieve.

3.3 The determinist response: re-interpret technology

I showed that both the response to embrace and to reject technology either quietly (ecocatastrophism) or explicitly (ecomodernism) accept the dichotomy between

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22. Hamilton, *Defiant Earth*, 42.

23. Meadows, 'Kurskorrektur oder bis zur Kollision'; quoted in van der Pot, *Steward or Sorcerer's Apprentice?*, 883.

nature and society.[24] The advent of the Anthropocene, with the explosion of non-human agencies, shows that this exact dichotomy has become untenable.

Fortunately, there *are* positions in the debate on technology which address this shortcoming. The position I would like to highlight is that of *technological determinism*. Determinists reverse the agency relation between humans and technology.[25] Instead of granting humans agency, with humans wielding technology as tools—the position of instrumentalism—it is technology that has agency *over us*. Technology develops autonomously, and this affects our human freedom. With this position, determinists succeed in recognising the radical character of the rupture brought about by technology, making their position compatible with the advent of the Anthropocene, which, after all, is highly mediated by technology. Furthermore, the Jevons paradox corroborates the determinists' thesis that technology answers to some internal logic and is indifferent to our attempts to modify its course.[26] Therefore, it is this response that I will explore further.

In this thesis, I build upon the work of technological determinist Jacques Ellul, because his idea of *autonomous technology* is close to our experience of technology in the Anthropocene. Ellul gives due attention to the entanglement of society and *technology*, arguing that they have become inseparable.

Although Ellul's technological determinism upsets the modernist ways of understanding agency, his distinction between society and *nature* is still largely modernistic. To be sure, Ellul technicises nature, but he seems ignorant to the Latourian notion of entanglement of nature and society, at least in his early work. This is a downside to Ellul's theory, but this deficiency is not unbridgeable. Peter Haff builds upon Ellul's idea of autonomous technology and he *does* consider the entanglement of nature and technology, arguing that technology has become a geological phenomenon. Haff also addresses the Anthropocene explicitly. Then again, because Haff is a (geo)physicist, not a philosopher, his theory lacks philosophical depth. This is why, for this thesis, I build upon the works of *both* authors in order to address my research question: Haff for an exploration of technology as a planetary

24. Cf. Latour, 'Agency Anthropocene', 15.

25. Smits, 'Langdon Winner', 154–55.

26. I cannot stress enough that the Jevons paradox is not a *proof* of determinism, but it is surely gesturing us in that direction.

phenomenon, and Ellul for the philosophical analysis of autonomous technology.

3.3.1 Is determinism fatalistic?

A common criticism of technological determinism is that it leads to *fatalism*, that is, the doctrine that human action has no influence on events.[27] One could say that determinism comes at a great price: our freedom. It is easy to see why determinism is susceptible to this criticism. If indeed technology has power over us, and we are incapable of resisting this power, we deflate human agency. If we lose our human agency completely, the future we face is grim: it will be as the ecocatastrophists imagine, but *without* the possibility of a way out by means of degrowth.

While I agree that the work of technological determinists like Haff and Ellul is susceptible to a fatalist reading, I also think an alternative reading is possible that resists the fatalist pull. In my discussion on Haff and Ellul in the next chapters, I will provide such a reading, showing how determinism can be compatible with human agency in the Anthropocene.

27. Definition after Blackburn, 'Fatalism'.

CHAPTER 4
Haff's technosphere

The fish is the last creature capable of understanding the water.

— Marshall McLuhan[1]

In this chapter, I explain what role technology plays in the Anthropocene, according to Peter Haff.[2] I start with discussing Haff, because his theory is a direct response to the rupture of the Anthropocene. I will then point out shortcomings in Haff's theory, which can be alleviated by augmenting his theory with the insights of Ellul—the task of chapter 5.

Haff has introduced a new term, *technosphere*, to refer to 'the set of large-scale networked technologies that underlie and make possible rapid extraction from the Earth of large quantities of free energy'.[3] The technosphere includes supporting systems that we usually would not immediately link to technology, such as governments and other bureaucracies, communication networks and cities.

According to Haff, we should think of the technosphere as a new *geological paradigm*. Geological paradigms are dynamic (i.e. energy-consuming or metabolising) systems that affect the Earth globally. Examples of earlier geological paradigms are the lithosphere and the hydrosphere. Like these earlier geological paradigms, the technosphere has a global scope: the technosphere covers the whole

1. Attributed to McLuhan in Schwarz and Jansma, *Technologische cultuur*, 9.

2. The first part of this chapter is based on an unpublished earlier paper of mine; see Meeuwisse, 'Technosfeer en nieuw antropocentrisme'.

3. Haff, 'Technology as Geological Phenomenon', 301.

Earth. Another similarity to previous geological paradigms is the origin of its raw materials. The technosphere gets its raw materials from other spheres: water from the hydrosphere, organic matter from the biosphere, building materials from the lithosphere.[4]

However, the main similarity between the technosphere and earlier geological paradigms is its *autonomy*.[5] We tend to think of technology as something under human control, Haff argues. Technology does not seem autonomous, but strictly dependent on humans. As we saw, ecomodernism still clings to this idea (section 3.1). Haff admits that technology indeed cannot exist without its (human) components. But this is true of *any* system: the survival of the system requires the participation of its components. For example, the water cycle cannot exist without the participation of H_2O molecules. It just so happens that for technology, many of the components are humans. The fact that the technosphere requires certain critical components, *even if they are humans*, does not yet distinguish it from other geological paradigms.[6]

With this, Haff's technosphere can be considered a form of technological determinism. He writes that

> in the technological world of the Anthropocene, most people are subject to the rules of—are essentially captives of—large systems that they cannot control (…). This state of human affairs is not meant as a metaphor or analogy, but as a physical necessity, a reality.[7]

Haff recognises that the idea of autonomous technology is not new, referring to works of both Ellul (*The Technological Society*, 1965) and Winner (*Autonomous Technology*, 1977).[8] Haff places himself in the same tradition as these authors, although he also departs from classical technological determinism. Whereas Ellul and Winner focus on the *social* and *political* aspects of technology, Haff places the

4. Haff, 302–4.

5. Haff also sometimes writes 'quasi-autonomous'. By this he means that we can shut down subsystems in the technosphere briefly in some situations, such as a web server in a cyber-attack *(my example)*, but never long-term.

6. Haff, 'Technology as Geological Phenomenon', 306–7.

7. Haff, 'Six Rules', 129.

8. See Haff, 127.

aspects of our relationship with technology on a more *(geo)physical* basis.[9]

4.1 Technology from within and without

According to Haff, the advantage of the notion of the technosphere is that it allows us to take an outside perspective on technology, instead of the inside perspective that is so commonplace in discussions on technology.[10] For us humans, it is natural to view technologies 'from the inside' because we design, manufacture, use and maintain them. We see technology as a derivative phenomenon of human activity. But according to Haff, that is only half the story. Humans are strongly *dependent* on the existence of the technosphere. Technologies are not simply phenomena made by humans, because people never made those technologies in isolation. They are always made in the context of pre-existing technological systems.[11] Because technology is never separated from humans, it is difficult to think clearly about technology from this *inside perspective*.[12]

The technosphere provides an outside perspective by regarding technique as an *emergent* complex system, where the system as a whole has properties that the parts do not have on their own. These large-scale dynamics appear spontaneously.[13] Moreover, the components in such an emergent complex system do not function independently from each other. They are dependent on the emergent properties of the larger system, for which their own actions provide support.[14] These components, such as humans in the technosphere, can only sustain themselves in a suitable environment—an environment they themselves help create. For instance, try surviving for a week without gas, electricity and running water. It is possible,

9. Haff, 127.

10. Haff, 'Technology as Geological Phenomenon', 302.

11. Haff, 301–2.

12. To emphasise the conditioning role of technology, Haff prefers the term 'technosphere' over 'anthroposphere'. The latter term would put unduly emphasis on the role of the human. In motivating this choice of terminology, Haff refers to Erich Hörl's Anthropocene illusion, which we saw already in chapter 1; see Haff and Hörl, 'Technosphere and Technoecology'.

13. A fantastic example that Haff does not mention, but depicts this phenomenon well, is John Conway's *game of life*. Based on a simple set of rules and a predetermined initial state, very complex patterns can emerge. See for example Gardner, 'Mathematical Games'.

14. Haff, 'Technology as Geological Phenomenon', 302.

but it greatly frustrates our functioning. So it is clear that people do depend on technology.[15]

While humans are essential parts of the technosphere, from this outside perspective we see that 'technology appears to have bootstrapped itself into its present state.'[16] With this, Haff moves the basis of our thinking about the climate from an anthropocentric to a systems-centric perspective.[17] Like the classical technological determinists, Haff resists the idea that humans are in charge of technology.

Although there are many similarities with other geological paradigms, the outside perspective also reveals some important differences. Particularly: why is the technosphere the only geological paradigm that wreaks havoc upon the Earth? Surely the water cycle does not cause a crisis! Haff acknowledges that, despite the many similarities, there are two main differences between the technosphere and earlier paradigms.

First, older geological paradigms are conservative in nature. This means that a pre-existing paradigm can survive the emergence of a new paradigm, even if that new paradigm captures some of the resources of the pre-existing paradigm. Haff points to examples of such earlier emergences of geological paradigms, like the solidification of the Earth's surface. This was the advent of the lithosphere, but it did not lead to the disappearance of the earlier magma ocean. Similarly the emergence of the biosphere modified the atmosphere, but did not destroy it.[18]

For the technosphere, this is different. The rapid growth of technology leads to the destruction of natural capital. For instance, urban growth and agricultural land use lead to deforestation and the extinction of species. In other words, the technosphere appears to abandon the conservative dynamics that were essential for its own emergence and functioning.[19]

Secondly, an established geological paradigm must be able to reuse its mass resources. The Earth is a closed system, in the sense that there is essentially no mass input or output. If the (finite) resources are not reused, they will eventually run out and the geological paradigm will cease to function. Reuse is therefore necessary for

15. Haff, 302.

16. Haff, 302.

17. Haff, 'Six Rules', 127.

18. Haff, 'Technology as Geological Phenomenon', 304–5.

19. Haff, 304–5.

the survival of a metabolic system.[20]

The technosphere falls short on exactly this point. While the technosphere recycles some of its materials, a large part is not recycled. The best example are CO_2 emissions in the atmosphere. This poor recycling means that in the long term, the technosphere will be unable to sustain its level of metabolism.[21]

4.2 Haff's theory of agencies

Drawing from the systems sciences, Haff develops a theory of agencies that we can apply to the technosphere.[22] To Haff, *agency* is the property of possessing a goal or purpose.[23] This is very similar to my definition of agency (see section 2.4). *Purpose*, then, is the goal that corresponds to this agency.[24] Note also that, as in my definition, intentionality is absent in Haff's definition of agency. This does not mean that Haff disregards human intentions, but he does put them in a different perspective, as we will see shortly.

Haff formulates three kinds of *fundamental* purpose that stem from his systems science. Haff calls these kinds fundamental, because they derive from the physical properties of the dynamic system—in our case, the technosphere. Fundamental purposes are necessary, but they can be realised in multiple ways. Next to these fundamental purposes, there are imputed purposes, that do not stem from the systems' physical properties. I provide an abridged overview of Haff's purposes in table 4.1.

4.2.1 Fundamental purposes

The first kind of fundamental purpose is a system's *intrinsic* purpose of survival.[26] All dynamic systems have the requirement of acting in a way that allows them to survive.

20. Haff, 305–6.

21. Haff, 305–6.

22. I provide an explanation of Haff's application of systems sciences to the technosphere in appendix B.

23. Haff sometimes uses 'purposiveness' as a synonym for 'agency'. For consistency, I will only use 'agency'.

24. Haff, 'Purpose in Anthropocene', 54; Haff, 'Technosphere and Relation Anthropocene', 140.

25. For the full, unabridged table, see Haff, 'Purpose in Anthropocene', 56, table 1.

26. Haff, 'Purpose in Anthropocene', 55–56.

Purpose		Meaning
Fundamental	Intrinsic	To survive
	Functional	To support the survival of the host system
	Provisional	To provide an environment in which the parts can fulfil their functional purpose
Imputed		A goal imputed by a human to oneself or to another system

TABLE 4.1 Abridged overview of Haff's framework of purposes.[25]

If a system did not, it would not even be possible to analyse it. The technosphere, like any dynamic system, metabolises energy in order to sustain itself. The behaviour of the technosphere is thus best described as acting-as-if-to-survive.[27]

What is more, the metabolic rate of dynamic systems tends to always increase. This is the principle of maximum entropy production (PMEP). According to this principle, a complex dynamical system evolves to a state of ever-faster energy consumption, until it runs into limits.[28] PMEP follows from the second law of thermodynamics, which states that 'any real process can only proceed in a direction which results in an entropy increase.'[29] Hence the intrinsic purpose of survival of the technosphere is not merely some extrapolation from the current tendencies of techniques; it is a necessary purpose, backed up by principles of physics.

The second kind of fundamental purpose, *functional purpose*, governs the relation of components towards its parent system. This kind of purpose acts bottom-up: the parts of a dynamic system act as if they were trying to support the survival of the system as a whole. For example, the functional purpose of the heart is *not* the circulation of blood, but rather the survival of the person.[30] In the Anthropocene, humans have

27. Haff sometimes calls intrinsic purpose a *final cause*, referring to the Aristotelian theory of causes, but he also stresses that final causes do not introduce forces into the technosphere; instead they are redescriptions of physical (i.e., causal) effects ('Technosphere and Relation Anthropocene', 141). Haff's comparison with Aristotle is ill-informed, because he clings to a physicalist understanding of the Earth system that would be highly incompatible with Aristotle's hylomorphism. I think Haff's clinging to physicalism is fair, since otherwise we would mistakenly re-introduce a kind of Aristotelian finality into our world.

28. See e.g. Kleidon and Lorenz, *Non-Equilibrium Thermodynamics*.

29. Schneider and Kay, 'Life as Manifestation of Second Law', 27–28.

30. Of course, the heart does have its own intrinsic purpose of survival too. But then we are coarse-

the functional purpose of supporting the metabolism of the technosphere.[31]

Note that the functional purpose of a part has nothing to do with its 'intended' design. A button may be designed with the purpose of holding up a pair of pants, but as a *physical property*, the functional purpose of the button stems from the dynamics of the pants-system it is a part of.

The third kind of fundamental purpose is *provisional purpose*, which governs the relation of the parent system toward its components. This kind of purpose acts top-down: the host system must provide a suitable environment to its parts so that they can function well. In the Anthropocene, this means that the technosphere provides for humans adequate food, shelter, etcetera to carry out their functional purpose.[32]

4.2.2 Imputed purposes

Next to these three fundamental purposes, Haff identifies a fourth kind of purpose that emanates from us. Humans have a tendency to attribute purposes to systems. As humans, we do not experience agency on the fundamental (physical) level. Instead we experience agency on an intentional level. That is, we tend to understand systems based on what they are intended to do. These intentions, however, are not inherent in the systems themselves (as a physical property); instead we *attribute* purposes to them. In the same way we can attribute purposes to ourselves. Haffs calls these *imputed purposes*.[33]

Since imputed purposes do not follow directly from the physical properties of the system, we may sometimes misinterpret the functional purpose of a system. For example, in reverse-engineering, we may attribute a purpose to a part that is incompatible with its actual functional purpose. Misinterpretation of the provisional purpose of technology is common too. We tend to think that technologies mainly provide for us, that we are the primary beneficiary of technology. My car helps me in getting from A to B. While this imputed purpose is compatible with the technology's functional

grained to the level of the heart, not of the person. See appendix B for an explanation of coarse graining.

31. From Haff, 'Purpose in Anthropocene', 56–57. This kind of fundamental purpose stems from Haff's rule of performance; see appendix B.

32. From Haff, 56–57. This kind of fundamental purpose stems from Haff's rule of provision; see appendix B.

33. Haff, 57–58.

purpose, we should realise that on this fundamental level, the primary beneficiary is the source of the technology: the technosphere.[34]

4.3 Merits and limitations

Let us take stock of the merits and limitations of Haff's theory. Haff's technosphere enables us to overcome anthropocentric biases of technology and allows us to criticise instrumentalism. A shortcoming in Haff's theory, however, is that it is too reductive, as we will see shortly.

4.3.1 Merit: overcoming anthropocentric biases

Haff claims that our perception of the Anthropocene is distorted, because we have a bias for proximate purposes. We are familiar with parts that have similar size as we do, because they are close and we experience and manipulate them immediately.[35] For instance, when I press the gas pedal on my car, the vehicle will start to accelerate. We seem to be in control of these technological systems.

But it is an anthropocentric illusion that we control large-scale technology too. The technosphere is a much larger system, so we cannot influence it directly.[36] Haff claims that modern humanity functions in a system that is beyond our own control: 'humans are components of a larger sphere they did not design, do not understand, do not control and from which they cannot escape.'[37] The focus on proximate purpose, where human agency is evident, obscures the role of distant, physical causes that have less direct effects.

Let's illustrate this with an example. The owner of a refrigerator can decide whether to turn it on and at what setting. Here human agency is evident. But the fridge is connected to an electrical power grid. This power grid is not under the fridge owner's control. In fact, it is under *nobody's* control. A system like a power grid is quasi-autonomous because it cannot be switched off by humans (except perhaps for a short time) and it functions largely without human intervention or even

34. Haff, 57.

35. In systems science parlance, these are called Stratum II parts; see also appendix B.

36. We say that the technosphere is a Stratum III system with respect to us. We are cannot influence this higher-level system directly, as expressed in the rule of impotence (see appendix B).

37. Haff, 'Six Rules', 131.

human knowledge. After all, the power grid contains many protective mechanisms to prevent its own shutdown, such as backup systems, redundancy, and reserve capacity. This autonomy of technology trickles down to all components, even to the artefacts we think we can control, such as the fridge. Just try keeping your fridge unplugged for a week. It is possible, but results in an extraordinary level of inconvenience, so we are strongly tempted to plug the appliance back in. We can say that the fridge resists our attempts to disable its functionality.[38]

4.3.2 Limitation: reduction to physics

While Haff's physical approach has succeeded in developing 'a nonanthropocentric description of the anthropic condition',[39] I believe that in his reduction of technology to the physical principles of dynamic systems, something is lost. By considering solely physical principles, Haff regards technology as a black box. What is more, he regards humans as black boxes as well. Humans are *also* reduced to their physical system properties, as formalised in Haff's theory of purposes. Haff does this, in his own words, 'to avoid metaphysical assumptions about the nature and importance of human values'.[40] But is the decision to approach technology from a systems science standpoint not in itself metaphysically motivated? I think that Haff is not justified in reducing humans to their physical system properties, and that we need to address this shortcoming.

To be clear, Haff does not completely brush aside the topic of human intentionality. With his concept of imputed purposes, Haff does a fair job in explaining the illusion of human control over technology. But Haff here reduces *all* human intentionality (at least on the personal level) to something ineffectual, an epiphenomenon of how our brains are wired, emphatically *not* causally efficacious in the system dynamics of the technosphere. For Haff, humans are causal entities in the technosphere, sure, but they do not gain that status by virtue of their intentional nature. The imputed purposes that stem from human intentionality may be correct or incorrect; regardless, they will not make a meaningful difference, as the system behaviour is

38. Haff, 'Technology as Geological Phenomenon', 306–7.

39. Haff, 'Purpose in Anthropocene', 55.

40. Haff, 'Being Human', 103.

independent from human intentionality.[41]

I think this is a step too far. Humans are clearly involved in the technosphere, because it is humans who design, develop and maintain technologies. While that might make us susceptible to anthropocentric biases, as Haff rightly points out, we do not need to go to the other extreme and deny human intentionality any importance whatsoever. It may be true that these technologies serve their own goal of survival, as Haff expresses in his intrinsic purpose, but that alone does not justify the reduction of human components to their functional purpose with respect to the technosphere. We are still in important ways involved in how technology develops. Haff does not address this adequately in his theory; he only offers the PMEP as an explanation for technological development.[42]

Let me illustrate how the application of the PMEP is insufficient for explaining why technology develops the way it does. Even if we accept that Haff is justified in applying the PMEP to the technosphere, we still need to grapple with the fact that possible technologies that increase energy dissipation in the system are manifold. One could use plenty of different sources of energy, and plenty of different technologies that make use of said energy. Why do some technologies come to fruition and others do not, even if they would all increase the rate of energy dissipation? Is this a purely contingent process? This seems unlikely to me, because humans do still participate in the process of technological development. Surely they use *some* criterion for selecting one means over another. Applying PMEP to humans is not straightforward. I am not saying that humans defy the principles of physics, but I *am* saying that humans have multiple degrees of freedom when it comes to *how* the PMEP is realised. While Haff's theory is compatible with humans having these degrees of freedom, he does not give any hints as to which path is actually taken, precisely because he disregards human intentionality.

To conclude, if we want to truly *understand* the development of technology, Haff's theory is too reductive. Specifically, the role of human intentionality is undeservedly brushed aside. This is why we need to augment Haff's theory with an

41. Haff, 'Purpose in Anthropocene', 54.

42. To be fair, Haff does say that humans can influence the technosphere if they become a collective force, a topic we will discuss in chapter 6, but my point here is not that Haff is fatalist, but rather that his theory does not allow us to explore how it is possible for humans to change the technosphere.

account of the internals of technology, in particular the role of humans therein. In his thorough, systematic, analysis of technology, Ellul does exactly this. In the next chapter, I will share what Ellul has to say on the matter, focussing on the notion of efficiency as the guiding principle of technological development. With this, the shortcomings in Haff's theory are addressed, and we see more clearly in what ways we can still exert our human agency in the Anthropocene.

CHAPTER 5

Ellul and the autonomy of technology

Since it was possible, it was necessary.

— Jacques Soustelle[1]

Jacques Ellul is among the first authors to characterise technology as an *autonomous* phenomenon. In this chapter, I explain what Ellul meant by this and how his insights can extend Haff's notion of the technosphere.

Jacques Ellul was born in 1912 in Bordeaux, France. His works move between sociology, history, and theology. According to Ellul himself, he is not a philosopher, but his sociological works testify to such philosophical depth that Ellul is almost universally recognised as a philosopher.[2] While Ellul has written on many topics, notably on propaganda, anarchy, and justice, he is best known for his works on technology. His views on technology are expressed in three main works, sometimes dubbed the 'technological triptych':[3] *The Technological Society* (1954), *The Technological System* (1977), and *The Technological Bluff* (1988).[4] Each work revolves around a different thesis. In *The Technological Society*, Ellul posits that in modern society, technology has become autonomous. In *The Technological System*, Ellul goes on to show that modern technology has become a coherent and integrated ensemble of elements. The elements

1. In Ellul, *Technological Society*, 99.

2. Tijmes, 'Jacques Ellul', 43.

3. Tijmes, 43.

4. Publication dates refer to the original French editions. English translations were published in 1964/5, 1980, and 1990, respectively.

can no longer be considered separately. Finally, in *The Technological Bluff*, Ellul argues that our expectations of modern technology are too high. Even if problems are *caused* by technology—which is evident in the current climate crisis—the solution is typically sought in technology.[5]

Although all books are relevant in considering the question of technology in the Anthropocene, recall that my research ultimately revolves around human agency in the Anthropocene. Therefore, Ellul's thesis that technology has become autonomous deserves the most attention, and it is *The Technological Society* that I will use as the main source for this chapter.

Ellul's method can be described as *transcendental* and *sociological*. It is transcendental, because Ellul does not perform a mere empirical investigation of technology, as that would only scratch the surface of technology.[6] Instead Ellul develops an account of technology itself, considered as a whole, backed up by empirical findings. He theorises about the societal conditions that make concrete technologies possible. It is sociological, because Ellul takes society as the starting point of his analysis. He constructs social facts that go beyond the individual and stem from collective acting and thinking. This style of sociology, in which social facts are investigated, is reminiscent of Émile Durkheim's approach, in which there is little room for personal commitment.[7] Here Ellul makes what I call the *sociological assumption*: he posits the existence of a collective social reality, independent from the individuals that make up society. Ellul grants individuals some inner sphere of freedom, but asserts that this sphere is not discernible at a general level of analysis: 'The individual's acts or ideas do not *here and now* exert any influence on social, political, or economic mechanisms.'[8]

Ellul has a somewhat peculiar terminology in regard to technology. Therefore, some explanation of definitions is in order. Ellul defines technique as 'the totality of methods rationally arrived at and having absolute efficiency (for a given stage of development) in every field of human activity.'[9] There are multiple techniques, which together constitute the *technical phenomenon*: the all-encompassing ensemble of all

5. Verkerk et al., *Denken, ontwerpen, maken*, 294–95.

6. Hanks, *Technology and Values*, 67.

7. Tijmes, 'Jacques Ellul', 44; Mitcham, *Thinking Through Technology*, 174.

8. Ellul, *Technological Society*, xxvi, original emphasis.

9. Ellul, xxxiii.

particular techniques that are used to secure some end.[10] In his later work, Ellul uses the term *technological imperative* to describe what drives the technical phenomenon: the drive towards efficiency.[11] Finally, we should understand concrete technologies, such as machines, merely as expressions and byproducts of the underlying technological imperative. While the machine is symptomatic of technique,[12] it is by no means synonymous to it. The machine represents the ideal of technique, whereas it is technique that makes the world compatible for machines.[13]

5.1 Old and new techniques

The best way to understand Ellul's characterology of modern technique is by contrasting it with traditional technique. In pre-industrial times, it was still possible to speak of 'man and the machine' as separate, more or less independent entities. But nowadays technique has entered into every area of modern life.[14] *Both* machine and man are integrated into technique; technique is not something external, but rather becomes the substance of man.[15]

In his discussion on the historical development of techniques, Ellul states that techniques have existed for ages, but they were always applied in limited domains, consisted of limited technical means, were only efficacious locally, both spatially and temporally, and left open the possibility of choice by humans.[16]

Around the 18th century, with the onset of the industrial revolution, these old

10. Ellul, xiv.

11. I apply the term 'technological imperative' retroactively to Ellul's *Technological Society*, although he only mentions the term twice (pp. 21, 358).

12. Ellul, *Technological Society*, 4.

13. With technology as expression of technique, I slightly deviate from Ellul's own terminology. Ellul defines technology as the *study of* or *discourse on* technique (τέχνη + -λογία), in the way biology is the study of life (βίος + -λογία). In the anglophone world, this distinction is hard to maintain, since the English word 'technology' refers both to the discourse and to its object of study. I use 'technology' in the everyday meaning of concrete, material technological artefacts (e.g. tools, machines, phones, cars). See Ellul, *Technological System*, 24, 33; Ellul, *Technological Bluff*, xin.

14. Ellul, *Technological Society*, 6–7.

15. This is how Ellul justifies his sociological approach: as technique is so entangled with social facts, it is in itself a sociological phenomenon that can be studied. See Ellul, xxxiii.

16. Ellul, 64–77.

characteristics of technique started to disappear, and were replaced with new characteristics. Whereas traditional techniques served human ends, modern techniques have no human ends to which they are subordinate (although it may *seem* so; I will come back to this). Instead, technique creates its own ends. In particular, *efficiency* is the driving force behind modern techniques. Societies started using an exclusively rational technique for designing technical applications: 'Technical progress today is no longer conditioned by anything other than its own calculus of efficiency.'[17] Whereas technical progress used to be personal, experimental, and workmanlike, nowadays it is abstract, mathematical, and industrial. According to Ellul, the break is so radical that 'today's technical phenomenon (…) has almost nothing in common with the technical phenomenon of the past.'[18]

To summarise, in the modern technological society, humans are conditioned by technique.[19] Techniques were supposed to liberate man from natural and social factors, but now man is determined by what was once his means of liberation.[20]

5.2 The characteristics of technique

After sketching out the difference between traditional and modern technique, Ellul then goes on to explain modern technique on the basis of a set of characteristics. Here I present those characteristics most relevant for understanding the agency of humans vis-à-vis that of techniques.[21]

17. Ellul, 74.

18. Ellul, 78.

19. It is worth noting that the conditioning of man itself is hardly a novel phenomenon. While the condition by modern technique is recent, starting from approximately the industrial revolution, Ellul stresses that sociological mechanisms have always been significant determinants for the individual (Ellul, xxvii). In premodern times, man was conditioned by social rules such as prohibitions, taboos, and rites. With the advent of the technological society, we have merely moved from one set of determinants to another as the most dominant.

20. Ellul, 'Search for Ethics', 11.

21. For a summary of the complete list of the characteristics as Ellul presents them, see Tijmes, 'Jacques Ellul'.

5.2.1 The automatism of choice

Ellul claims that there is always 'one best way' in solving technical problems.[22] The selection of method is the result of a rational, mathematical process. When the best possible method has been selected, the technical movement becomes self-directed. Ellul calls this process *automatism*.

Automatism has two aspects. Firstly, technique selects its own best means to be employed. The human is no longer the agent of choice, although he may think he is: 'He can decide only in favor of the technique that gives the maximum efficiency.'[23] Ellul gives an example of comparing the magnitude between three and four: no matter the characteristics of the individual, four will always be larger than three. There is no personal choice here. Ellul remarks that in principle, a machine could make these kinds of decisions as well, corroborating that the selection process does not represent choice.[24]

Secondly, all problems are *presented* as technical problems: 'It is not in the power of the individual or of the group to decide to follow some method other than the technical.'[25] This is reminiscent to the solutionism we saw in the introduction. Whereas there used to be spheres of life outside the technical domain proper, these spheres are increasingly being invaded by technique. There is less room for spontaneous activities, because they are not rationally or systematically ordered and thus are incompatible with the technique. As a contemporary example, consider dating. Finding a romantic partner used to be a messy, non-ordered process. But now we have dating apps like Tinder, which approach dating as an engineering problem that can be solved with technologies. Potential partners are neatly lined up, waiting for us to be swiped to indicate our preferences.

5.2.2 Self-augmentation

Automatism shows that humans are no longer the agent of choice, but surely humans *do* participate in the technical phenomenon—as we already saw in Haff's tech-

22. Ellul, *Technological Society*, 79.

23. Ellul, 80.

24. Nowadays we see that machines indeed make such decisions, such as in parameter optimisation of decision systems.

25. Ellul, *Technological Society*, 84.

nosphere. Ellul agrees that humans do participate, but in a way that is subordinate to the search for efficiency. This is why he calls the development of technique self-augmenting. Humans resist the currents that are nowadays considered secondary, such as aesthetics, ethics, and fantasy.[26] While technique progresses as the result of human efforts, at the same time 'technique sharply reduces the role of human invention.'[27]

Ellul stresses that the accumulation of small improvements is more decisive for technical progress than some break-through inventions by individuals. Genius plays a negligible role in technical development. He points at multiple discovery as evidence: identical technical inventions are often produced at approximately the same time in different places of the world.[28] The phenomenon of multiple discovery opposes the 'heroic' theory of invention by great scientists or geniuses.

More profoundly, Ellul claims that technique tries to eliminate all human variability. This is done for instance in factories, where an ever increasing part of production is automated. Man's role is limited to inspection, Ellul says. Put differently, the human is taken out of the decision making loop. This may sound bad, but actually this process of removing the human from techniques is generally taken as a good thing. 'Freeing man from toil,' Ellul writes, 'is in itself an ideal.'[29]

5.2.3 The unforeseeability of effects[30]

In chapter 2, we saw how unintended consequences of our actions disrupt the functioning of the Earth system. In 1954, Ellul already made similar remarks with respect to the unintended consequences of technique. According to Ellul, humans can never foresee all consequences of a given technical action. Despite this, the action is inevit-

26. Ellul, 74.

27. Ellul, 86.

28. See Ellul, 86. Ellul does not provide examples himself, but some spring to mind. For one, infinitesimal calculus was formulated independently by Newton and Leibniz (Berggren, 'Calculus'). An even more incredible example is the invention of the telephone. In 1876, Elisha Gray and Alexander Graham Bell independently filed patents for the invention of the telephone, on the exact same day (Borth, 'Telephone').

29. Ellul, *Technological Society*, 136.

30. This characteristic is not listed separately by Ellul, but I think it is important enough to be discussed as a separate characteristic.

able, because we can only see the *foreseeable* effects. Unforeseen negative secondary effects may lead to a situation worse than the status quo, but the *foreseen* effects always represent something valuable and positive.[31]

A techno-optimist may counter that while there have been cases where technical actions were disastrous, we should try to separate the good results of a technical application from the bad. But this, according to Ellul, is impossible. The good and bad effects always go together. Technical advances always lead to new, secondary, unpredictable effects.[32]

As an example, Ellul points to the deforestation in Brazil caused by agricultural innovations. Many tropical forests were cut down in order to grow sugar cane and other crops. In the short term, this agricultural innovation led to productivity gains. But deforestation also led to changes in the hydrographic features of the landscape. Rivers became torrents that swept away the fertile topsoil, making agriculture impossible. This rendered vast areas of land infertile. Ellul's point in this example is not to show that deforestation was the incorrect technique to be applied, motivated by capitalist prospects of short-term profits, but rather that technique is *always* considered as valuable and positive. Only if we take the secondary, unforeseen effects into account may we conclude that it would have been better to not apply the technique at all—but since the effects are unforeseen, they are not taken into consideration in the decision-making process.[33]

Note that Ellul does not aim to show that technique will end in disaster. Quite the contrary: technique is aimed at efficient ordering. Impending doom is not exactly efficient *or* ordered. Ellul merely tries to point out that it is an illusion that we can suppress the 'bad' side of technique and preserve the 'good'. This is an illusion precisely because the good and bad consequences of the technical phenomenon are inseparable.[34]

31. Ellul, *Technological Society*, 104–5.

32. Ellul, 106.

33. Ellul, 104–5.

34. Ellul, 111.

5.2.4 Autonomy

With these characteristics in place, Ellul takes a step back to observe the entire technical phenomenon, and concludes that technique has become autonomous. Technique has become an independent whole with respect to social, economic and political relations.[35] We should not understand the autonomy of technique in the Kantian meaning of capacity for self-government (αὐτο-: self; νόμος: law), but rather as a form of self-determination or *closedness*: according to Ellul, technique is an end-in-itself that does not tolerate judgment from outside.[36] 'Technique modifies whatever it touches, but it is itself untouchable.'[37] As such, autonomy is not opposed to heteronomy (being influenced by authority or tradition), but rather opposed to an openness towards others and their goals.

Closely related to this autonomy is the idea of unstoppable technical progress. This idea is common in political discourse. Dutch philosopher Hans Achterhuis points to research by Dick van Lente, who observes that the idea that technical progress cannot and must not be stopped is prevalent in *all* major Dutch ideological movements (liberalism, socialism, catholicism and protestantism). Although politicians of these movements present technical progress as something positive, progressive, and/or salvific, the underlying substantive claim is the same as Ellul's, namely that the progress of technique is autonomous. The idea is the same, but the sign is reversed.[38]

Of course, there *are* limits to the autonomy of technique. For instance, technique is not autonomous with respect to physics; it still has to obey the laws of nature. Since technique cannot defy the laws of physics, it instead seeks to dominate them. The result is a modification of *humans*, so that they fit better with the techniques. This is how autonomy of technology leads to determination of humans. As an example, Ellul shows that techniques require a mechanical kind of time in order to function well, referring to Mumford's analysis.[39] For instance, assembly lines need precise timetables in order for the machines on the line to cooperate automatically. Here, it is humans

35. Ellul, 133–34.

36. Ellul, 93, 133; Ellul, *Technological System*, 125.

37. Ellul, *Technological Society*, 94.

38. Achterhuis, *Natuur tussen mythe en techniek*, 146–47; Achterhuis, *Maat van techniek*, 34–36.

39. See Mumford, *Myth of Machine 1*, 286.

that needed to adapt. Humans used to get along fine without measuring time precisely, letting one's rhythm be guided by nature and life's needs. But nowadays humans have become subject to working in strict time shifts, eating, working and sleeping according to mechanical time.[40] The clock, as a technical invention, is a way of framing time in a way more agreeable to technique.

5.3 The efficiency principle

I concluded the previous chapter on the note that Haff's explanation of the internal workings of technology in the technosphere, in the form of the principle of maximum entropy production (PMEP), is lacking in explanatory power. It serves to explain what the fundamental purpose of technology is, but not how that purpose is achieved. Ellul provides an alternative, possibly better principle, namely *efficiency*, as expressed in his technological imperative. Although Ellul does not use the term 'efficiency principle' himself, it is the principle which underlies *all* characteristics we saw in the previous section.[41]

Like Haff, Ellul stresses that technique *seems* to serve human goals, but this is illusory. Ellul argues that no finality is possible for technique, where he understands finality as the presence of human-dictated goals that *direct* the progression of technique.[42] Surely, we *mention* finalities in discussions on technology. For instance, we may say that techniques benefits our 'happiness' or 'liberty'.[43] But Ellul counters that 'they are merely justifications that are tacked on because man is unwilling to lose face, unwilling to appear subjugated to causalist mechanisms, and always wants to affirm himself as master of the situation!'[44] The phrases serve only to justify what technique is already doing; they are always *a posteriori* additions to pre-existing tech-

40. Ellul, *Technological Society*, 137–38, 328–30.

41. We saw it before in the definition of technique ('having absolute efficiency'; Ellul, xxxiii), in the defining feature of modern technique ('no longer conditioned by anything other than its own calculus of efficiency'; Ellul, 74), in the automatism of choice ('decid[ing] in favor of the technique that gives the maximum efficiency'; Ellul, 80). Effectively, efficiency is the only criterion in the automatism of choice in the technological society. See also Son, 'Ellul's Efficiency Principle', 49.

42. Ellul, *Technological System*, 256–57.

43. Cf. Ellul, *Presence of Kingdom*, 66.

44. Ellul, *Technological System*, 257.

niques. Technique itself does not need these justifications; 'technology develops because it develops.'[45]

And indeed, if one is asked what is meant by values like 'happiness', one falls silent. Surely happiness has to be more than leisure and consumption? But then happiness becomes surprisingly difficult to define. Nonetheless, all major ideologies are in favour of advancing the happiness of mankind. People believe in happiness and assume that technology can assure happiness. Happiness is perfectly vague and insubstantial, and therefore it is a satisfactory, tacked on justification for technique.[46]

This being said, a clarification is in order. The absence of finality does *not* mean that technique develops completely independently from human desires and needs. Langdon Winner, in his discussion on Ellul's *Technological Society*, puts it succinctly:

> No one has argued that technology and human motives have parted company in an absolute way. (...) [Ellul] takes care to emphasize the fact that human beings are present—desiring, thinking, deciding, acting—at each step in the technological progression. The weight of his message is, however, that such desire, thought, decision, and action are very thoroughly corrupted by circumstances which arise from modern man's adaptation to technique.[47]

Hence in the decision making process, only instrumental concerns play a decisive role. Values like 'happiness' have become so abstract and implicit that they do not have any formative power left; they are empty phrases.[48]

Winner points out another aspect that highlights how human ends are adventitious in technical progress. He argues that human ends are adjusted to match the character of the available means. Winner calls this process *reverse adaptation*.[49] Because humans grow up in a technological environment, they come to internalise norms and values of technique *as if* they are human norms and values. Our way of thinking is altered and we now apply values like efficiency and speed in spheres of life where

45. Ellul, 267.

46. Ellul, 257.

47. Winner, *Autonomous Technology*, 227.

48. Winner, 232–33.

49. Winner, 229.

this previously would have been inappropriate.[50] No one questions the value of efficiency and it becomes a universal axiom for human conduct.[51] Ellul worries about this: is efficiency actually what *we* want? Or is it something we are led to believe we want?[52]

Langdon Winner provides a concrete example of reverse adaptation, of how the ends are adjusted to match the available means. After NASA had successfully flown men to the Moon, they were left with an aerospace team, consisting of many technicians and pieces of equipment, with nothing to do. Many proposals were put forward: perhaps we could design a space shuttle, or we could explore some other planets, like Mars or Venus. But the argument is always the same: whatever happens, the aerospace team must not be dismantled: 'Give the system something to do. Anything.'[53] Hence the original means—the aerospace technology—has now become an end in itself, for which additional ends are constantly introduced in order to justify maintaining the system.[54]

5.3.1 The efficiency of *what*?

Ellul's efficiency principle has been criticised from multiple directions. The criticism mainly boils down to the question: what exactly is being optimised? In order to understand this criticism, let's first consider how we can define efficiency. The modern, technical sense of efficiency is defined as a ratio of inputs and outputs. The most efficient solution is the one that produces maximum outputs for minimum inputs.[55] In situations where we can quantify the inputs and outputs, we can write the efficiency η as the fraction

$$\eta = \frac{\text{Outputs}}{\text{Inputs}}, \text{ subject to } C,$$

where C is a set of constraints. The optimisation problem is then finding a solution that maximises η.

50. Think back of the Tinder example from section 5.2.1.

51. Winner, *Autonomous Technology*, 229.

52. See also Gertz, *Nihilism and Technology*, 106.

53. Winner, *Autonomous Technology*, 245.

54. See Smits, 'Langdon Winner', 157.

55. Mitcham, *Thinking Through Technology*, 225; Winner, *Autonomous Technology*, 229.

Efficiency is a context-dependent notion: depending on the problem at hand, we decide what to include as relevant inputs and outputs. So what counts as the most efficient choice is a matter of perspective; it depends on what we include in the calculus of efficiency—inputs and outputs—and what is left out. The philosopher Stanley Carpenter, in his discussion on the norm of efficiency, puts it as follows:

> We admit, on reflection, that every calculation of efficiency involves the drawing of boundaries, a deliberate focusing on some properties and the ignoring of others.[56]

Criticism on Ellul's efficiency principle has to do with this context-dependency. The criticism is twofold. There is the logical argument, according to which Ellul fails to say *what* is being optimised in the efficiency calculus, and there is the historical argument, according to which technological decisions are often made based on other criteria than efficiency.

Let's first look at the logical argument, as put forward by Albert Borgmann. He argues that there is a logical flaw in Ellul's argument. Ellul states that the autonomous development of technology stems from its following a logic of efficiency. But at the same time this efficiency is the distinctive feature *of* technology! Borgmann counters that this argument is circular, since technology follows 'its own unexplained explanation.' Efficiency, the principle of technology, serves to explain everything, but remains itself unexplained.[57]

To clarify his argument, Borgmann points out that the concept of efficiency requires some 'antecedently fixed goals on behalf of which values are minimized or maximized.'[58] Efficiency can never be a goal on its own, because efficiency is always efficiency *of* or efficiency *for* something. The context-dependency of efficiency, as we saw in the definition above, means that we can only meaningfully speak of efficiency if we provide the goals, that is, if we draw the boundaries of the relevant context. Borgmann accuses Ellul of failing to provide these goals, as he merely states that efficiency *is* the goal of technique. This can never be the full explanation, because we

56. Quoted in Son, 'Ellul's Efficiency Principle', 54.

57. Borgmann, *Technology and Contemporary Life*, 9; see also Verbeek, *What Things Do*, 174.

58. Borgmann, *Technology and Contemporary Life*, 9.

would be left in the dark as to what is being optimised.[59]

We can find the confusing nature of Ellul's efficiency principle in his own text. When he describes the relation between liberal capitalism and technical progress, Ellul notes that whereas the technological imperative is oriented towards maximum efficiency, capitalism is oriented towards maximum profit.[60] But we might as well rephrase the opposition, saying that technology aims for maximum *technical* efficiency whereas capitalism aims for maximum *economic* efficiency. As long as efficiency remains ill-defined, we can argue that *both* are forms of efficiency; only the context is different. And, to get back to Borgmann's argument, technical efficiency is especially ill-defined; we know that many technical processes are extremely wasteful, producing a lot of pollution, and yet according to Ellul they count as efficient. At least with economic efficiency we know *what* is being optimised, namely the profits. Optimising efficiency *itself* is an empty notion, impossible to understand without reference to *some* goals.

Borgmann's logical argument is augmented by the historical argument that social constructivists of technology put forward. According to the social constructivists, the design objectives in the engineering practice can differ from one project to another. Design is a tradeoff process in which the definition of 'best' depends on the values of the designer, user, and other relevant stakeholders. Efficiency is only one criterion here. There are many other criteria that play a role in the decision making process, such as political desirability, cultural appropriateness, and aesthetics. As an example, social constructivists Pinch and Bijker show that the design of the bicycle is the result of a highly contingent process, not the result of a unidirectional process governed by the efficiency principle. In the design of the bicycle, safety was preferred over speed.[61] This seems at odds with the efficiency principle and runs counter to Ellul's idea of 'one best way' in the automatism of choice. Carl Mitcham, who is not a social constructivist himself but discusses the field, explicitly criticises Ellul on this point, alleging that Ellul knows little about the real world of engineering.[62] It is far too crude to say that efficiency is the only criterion; there are many.

59. Borgmann, 9.

60. Ellul, *Technological Society*, 200–201; see also Rogers, 'Technological Society', 73.

61. Pinch and Bijker, 'Social Construction of Facts'.

62. Mitcham, *Thinking Through Technology*, 141.

Critical theorist Andrew Feenberg expresses this citicism succinctly in his *paradox of the frame*. According to Feenberg, 'efficiency does not explain success; success explains efficiency'.[63] The technique selected is not the most efficient one, as Ellul would have it; it is rather the result of contingent historical circumstances. After the improved technique has been developed, we look back and fool ourselves by thinking that its efficiency led to its success. But this is a constructed picture and has little to do with the actual design process.

5.3.2 Reply

Ellul provides a reply to the objections raised. He concedes that there are indeed differences in techniques developed within different contexts. Technique does not lead to general uniformity, because we are in a transitional period in which the old is slowly dying out, and the 'one best way' can vary with climate, country and population. But these are accidents of what is essential, namely technique[64]—and hence, by the definition of technique, efficiency. All civilisations are on the same trajectory of technique, although they may be on different points on that trajectory.[65]

Is this defence strong? To me, referring to a distinction between essence and accident is a devious way of separating out phenomena: those that fit the theory are 'essential' and those that do not are brushed off as 'merely' accidental. I think we can do better, *without* giving up on Ellul's principle of efficiency. Borgmann is right when he argues that Ellul fails to define technical efficiency accurately. But does that mean that efficiency can no longer serve as the defining criterion of technique? Not necessarily. In what follows, I will argue that we can save Ellul's efficiency principle by understanding it not as a description of the factual efficiency achieved, but rather as the *justification* for the introduction of techniques. I call this the revised efficiency principle. I build this argument on the work of Korean philosopher Wha-Chul Son.[66]

Recall that in his discussion on the automatism of choice, Ellul says we can only choose for the solution that results in the maximum efficiency (section 5.2.2). But we also know that we can never compute the achieved efficiency beforehand, because of

63. Feenberg, 'Ten Paradoxes of Technology', 7.

64. Ellul, *Technological Society*, 130–31.

65. Ellul, 117.

66. See Son, 'Ellul's Efficiency Principle'.

the unintended consequences that each new technique brings (section 5.2.3). What guides our choice, then, is not so much the actual efficiency achieved, but rather whether the new technical solution *presents* itself as more efficient than the status quo. Son notes that 'Depending on which elements are included in the calculation, anything can be considered efficient.'[67] The real characteristics of the technical solution are not at all relevant, because we cannot see them (unintended consequence) or perhaps we *can* see them, but we wilfully or unintentionally ignore them. So the actual efficiency, if we even can speak of such a thing, is completely inconsequential in the introduction of a new technical application.

An example. When a motorway suffers from congestion, it is often argued that we should add an extra car lane. The extra lane is justified because it will reduce traffic jams, thereby shortening travel times and improving efficiency. This is the context in which the decision is made: the new solution (an extra lane) presents itself as more efficient as the status quo (lots of traffic-jams), and is therefore accepted. But we know from empirical findings that a higher traffic capacity induces a higher demand for travel.[68] After a new car lane is realised, in the short term travel times are indeed reduced. But in the long term more people will prefer the car over other means of transit (or over staying home), and the travel time benefits of the extra lane are negated. Again, this is a case of the Jevons paradox. What is more, we have now introduced additional problems: emissions from motorised traffic have increased, and we may have sacrificed strips of nature in order to build the extra lane.

Or consider the smartphone.[69] We tend to say that smartphones have made our lives more efficient. What do we mean by that? If we mean by efficiency the speed in which we can navigate in a city, then yes, a smartphone with a navigation app may provide us with a more efficient means. But smartphones have modified our lives in many other ways: we have become much more dependent on power sockets in our vicinity, or else our smartphone battery dies; we may have become addicted to social media, wasting our time scrolling through meaningless content; we spend less time meeting up with friends face-to-face. Do these aspects count as efficiency improvements? Likely not, at least not from the perspective of the user, but these aspects were

67. Son, 'Ellul's Efficiency Principle', 54.

68. E.g. Downs, 'Law of Congestion'.

69. Example adapted from Son, 'Ellul's Efficiency Principle', 54.

not taken into consideration when the smartphone was introduced and sold to us, so they did not affect our judgment of the efficiency of the appliance. And now we are in too deep; the smartphone has firmly established itself in our way of life and we cannot simply go back to an era before the smartphone.

When we start to understand Ellul's efficiency principle as a means of justification, as an argumentative tool, Borgmann's criticism no longer applies. While Borgmann is perfectly right that Ellul fails to provide the goals that are being optimised, the crux is this: the actual goals that are being optimised do not matter! Son puts it as follows:

> The problem is not that Ellul used the term [efficiency] inaccurately, but that an inaccurate concept was being used for justifying and perpetuating the current trend of technological society.[70]

Borgmann was percipient in noting that Ellul failed to define the input and outputs of the efficiency calculus, but failed to see that we do not *need* to define them in order to explain technical development.

What about the historical argument put forward by the social constructivists? For my response, recall that the social constructivists reject Ellul's autonomy, according to which technical progress can only proceed in the direction that leads to ever increasing efficiency. By pointing out the contingency of the engineering design process, as Pinch and Bijker do,[71] the social constructivists aim to show that technological development does not follow a fixed path towards ever increasing efficiency.

But here is the kicker: if we understand Ellul's efficiency principle as a means of justification, we would *agree*! Son says that under this notion, the historical evidence for the efficiency principle is not based whether the technological development was *actually* more efficient, in terms of inputs and outputs, but rather whether efficiency is accepted as the main reason for the technological development.[72] After all, we saw in the examples of the motorway and the smartphone that actual efficiency is inconsequential in technical progress; what matter is if efficiency is brought up as a justification for the changes.

70. Son, 54.

71. Pinch and Bijker, 'Social Construction of Facts'.

72. Son, 'Ellul's Efficiency Principle', 55.

Feenberg's paradox of the frame in fact is in concordance with the revised efficiency principle. Feenberg says we are fooled into believing that superiority—in terms of efficiency—explains the success of a line of development, and that is what the revised efficiency principle says as well: 'Whether it is efficient or not, every technological choice should be justified in terms of efficiency,' argues Son.[73] So what matters in technological development is not the actual efficiency gain but rather how the new solutions are presented to us as being more efficient. Efficiency becomes a matter of framing, not something measurable in terms of inputs and outputs.

With this, I conclude my discussion on Ellul's autonomy of technique and the efficiency principle. In the next chapter, we shall see how Ellul's (revised) efficiency principle relates back to Haff's technosphere, in order to draw a completer picture on human and technological agency in the Anthropocene.

73. Son, 55.

CHAPTER 6
Human response-ability in the Anthropocene

> *The technosphere has agency, and that that agency is not the same as our own.*
>
> — Peter Haff[1]

I started my thesis with the question on human response-ability in the Anthropocene. In the subsequent chapters, we saw that technology presents itself as serving our needs, but really technology is devoid of any finality. Technology behaves as an autonomous phenomenon; it only answers to the principle of maximum entropy production (Haff) or to its internal calculus of efficiency (Ellul). Langdon Winner, in his discussion of Ellul, puts our predicament as follows:

> By its systematic confounding of processes of thought, motivation, and choice, modern technology tends to remove its workings from effective direction by human agency. The results of this tendency so closely approximate a self-generating, self-sustaining technical evolution that efforts to argue for the reality of human guidance seem completely vain. Of course, *in principle* man is always at the control panel. But this is increasingly a principle hollow of any living substance.[2]

With regard to our technospheric condition, this is bad news: the technosphere is

1. Haff, 'Technosphere and Relation Anthropocene', sec. 4.1.7.
2. Winner, *Autonomous Technology*, 236.

threatening the continued existence of humans on Earth, and we appear not to be in charge. If we are indeed unable to adjust the Earth's course towards impending catastrophe, attempts to counter the negative anthropogenic impacts on the Earth system would be in vain. What is more, our very survival may be at stake.

But we should not give up all hope just yet. In this chapter, I will argue that recognising the agency of the technosphere does not mean that we have lost all agency of our own. Yes, from the determining character of technique, we should conclude that the metaphor of spaceship Earth is misleading, because the Earth lacks the required chain of command for us to be at the 'steering wheel'. But at the same time, we are in important ways still capable to influence the workings of the technosphere. That is, we may still be able to exert human response-ability. We can utilise the revised efficiency principle from the previous chapter to our advantage, especially if we find ways to work along with the momentum of technology, instead of working against it.

In this chapter, I will first investigate the existential risks associated with the technosphere. I will then, by investigating the kind of determinism that is at play, show possible ways to escape from these risks.

6.1 Asymmetry and existential risks

Ellul and Haff agree with each other in positing a kind of *asymmetry* between humans and technique: they are not on the same footing. While technique influences us, it is very hard for human individuals to influence technique. For Ellul, the asymmetry is best expressed in his sociological assumption (the positing of a technological society independent of its individual human members); for Haff, it is best expressed in his rule of impotence. The asymmetry between humans and technique can be dangerous for humans, but Ellul and Haff identify very different kinds of existential risks.

Ellul is worried that the technological society may lead to total subjection to technique. We cannot expect salvation from the ones who contribute to the creation of the technological society, since they are convinced that what they are doing is right. The scientists and technicians believe that what they are doing is for the sake of human happiness—a vague *a posteriori* justification, as we saw in section 5.3—and they criticise everyone questioning their motives:

> All that [questioning of motives] must be the work of some miserable

> intellectual who balks at technical progress. The attitude of scientists, at any rate, is clear. Technique exists because it is technique. The golden age will be because it will be. Any other answer is superfluous.[3]

Crucially, Ellul notes that no escape from the technological society is possible: 'one is obliged to participate in all collective phenomena and to use all the collective's tools, without which it is impossible to earn a bare subsistence.'[4] Whereas it used to be possible to break away from technology and live as a hermit,[5] even this possibility is now taken away, and he who tries nonetheless ends up on the 'social rubbish heap' of society.[6]

Haff associates a very different existential risk with the technosphere, at least on first sight. According to him, we are at risk of becoming superfluous. Haff writes that if technological change were slow, we would likely only have to worry about the environmental challenges that the technosphere poses. But technology is changing rapidly. As a consequence, the demands that the technosphere places on humans may change too.[7] As the technosphere continues to increase its rate of metabolism, it continually tries to 'find and develop new pathways and enhance existing ones in pursuit of its intrinsic purpose of survival.'[8] This race towards efficiency is dangerous, because it renders humans at risk of becoming obsolete in the technosphere, argues Haff. In that case the technosphere may cease providing for us, as we become superfluous components.

One may think such a warning is farfetched, but Haff counters that we can see these mechanisms at play already. Mechanisation and later automation of labour have led to the vanishing of many occupations. There are hardly any telephone operators and parking garage ticket-takers left. People with a poor education, as well as ill and elderly people, are most easily displaced by the technosphere.[9]

For now, the former telephone operators and ticket collectors have at least to

3. Ellul, *Technological Society*, 436.
4. Ellul, 139.
5. Ellul, 77.
6. Ellul, 334.
7. Haff, 'Being Human', 105, 107.
8. Haff, 107.
9. Haff, 107.

some extent been able to find alternative occupations in order to continue to fulfil their functional purpose with respect to the technosphere. But it is not clear if this will remain possible in the long term. Haff speculates that in time, occupations that require more complex skills, such as airline pilots and educators, may face a similar fate. It is possible that eventually all human participation in the technosphere may become superfluous, for instance because of a takeover of human functions by artificial intelligence.[10]

I park the question whether the possibility of a technosphere without *any* human contribution is credible, because it is not relevant to my discussion. In any case, it is credible enough that at least a large group of humans is at risk of becoming displaced by the technosphere. If these humans are replaced with more efficient non-human systems, we can expect the technosphere, under the provision rule, to stop providing for them, denying them the goods and services that once sustained them. Haff calls this the problem of 'ineffective recycling of humans'.[11] According to Haff this is a greater risk to our survival than the lack of carbon recycling. For Haff, the only way for humans to sustain their wellbeing is by continuing to provide value in return (humans' functional purpose w.r.t. the technosphere), through some kind of performance. But, to speak in Ellulian terms, that would require total adaptation of the human to technique—and so we are thrown back to the existential risk that Ellul puts forward: that of total subjection. What we see is that Haff's initial existential risk is very different to Ellul's, but once we take into account Haff's remark about the need for our continued providing of value to the technosphere, Haff's existential risk is reduced to the one that Ellul put forward.

From this preliminary investigation of existential risks, we can conclude that both under Ellul's and Haff's accounts, our response-ability is at stake.

6.2 Determinism revisited

The existential risks put forward by Ellul and Haff are real, but they are not unavoidable. In order to investigate how we might avoid them, we should explore *what kind of determinism is at play* in Haff's and Ellul's theories. Throughout this thesis, I have

10. Haff, 105–7.

11. Haff, 108.

called both Haff and Ellul technological determinists. With this, I meant that these authors recognise that technology has agency and that this agency affects humans. It is impossible for us humans to regain control over technique, as we are not the free and autonomous subjects modernity has led us to believe. But does this mean that we are completely determined, that technological agencies control us completely, that we have lost all our agency? Not necessarily. In this section I will show why; I will revisit their theories, looking at similarities and differences between the two, to see how technological agency can be compatible with human agency.

Whereas the human–technology asymmetry is present in both Haff's and Ellul's work, the principle underlying the asymmetry is different. For Haff, as we know, it is the principle of maximum entropy production (PMEP) that drives the technosphere. Humans, qua parts of the technosphere, need to act in ways that support the fundamental purpose of the technosphere, which is survival or increasing energy dissipation. Ellul on the other hand grounds the asymmetry in the technical imperative, as expressed in the efficiency principle (section 5.3), in which humans come to accept new technical solutions because of their (alleged) improved efficiency.

Here we observe an important difference between the underlying principles. Haff's PMEP is a physical principle. Like all physical principles, it is ahistorical: it has always been true and will always be true. While that does not mean that the development of the technosphere is ahistorical, it does mean that the principle underlying its development is, hence we are not in a position to modify it—in the way we cannot modify the laws of physics.[12]

Contrary to Haff, whose PMEP is impossible to modify, Ellul does not base his technical imperative on an unshakable ahistorical principle. After all, Ellul argues that the old techniques had very different characteristics than the modern ones; the current technological society is the result of a historical process. The technical imperative may present itself to us as inescapable, but if it does, that is only because we have closed our eyes to non-technical alternatives.[13]

I have already mentioned that Ellul is often accused of fatalism (section 3.3.1). Un-

12. In section 4.3.2, I already questioned whether we are justified in characterising the 'laws' of the technosphere as natural laws, since clearly, the technosphere is not *merely* a physical phenomenon, as humans are involved as well.

13. Cf. Rogers, 'Technological Society', 71.

der this accusation, Ellul's work would imply that we can't escape from our fate and total domination of our lives by technique is inevitable. The argument takes the following shape: *If* Ellul's theory is right and everything will happen as Ellul describes it, *then* humans are helpless, unable to preserve their personal freedom or to change the course of events.[14]

Ellul resists this reading of his work. He reverses the terms of the implication, arguing instead that *if* humans abdicate their responsibilities with regard to values and lead a trivial existence in a technological civilisation, *then* Ellul's theory is right and everything will happen as he describes it.[15] Hence Ellul is not fatalistic at all; he merely describes the *most probable* evolution of the technical phenomenon, not an inevitable evolution. In pursuing this probabilistic approach, Ellul concedes that contingent decisions of individuals may modify the course of social development. What is more, we may witness a major event such as the outbreak of a world war, or even an act of God that changes the course of events. But since Ellul cannot predict those, the best way forward is to sketch the most probable path by extrapolating current tendencies in society.[16] Where that most probable path leads, we saw in chapter 5.

What we see, then, is that while in Ellul's theory technique is autonomous in *practice*, determining us, Ellul rejects any kind of *metaphysical* technological determinism, in which acting differently is fundamentally impossible.[17] So for Ellul, it *is* possible to take action in order to change the course of events, at least in principle. His deterministic vision on technique is not fatalistic, quite the contrary: it offers us more realistic possibilities to take action. Applied to our technospheric condition, that would entail that we may be able to mitigate anthropogenic impacts on the Earth system. But is this enough? It is comforting that Ellul's determinism is theoretically compatible with exerting human agency, how slim our chances may be to affect change. But don't we *also* need to deal with PMEP? What are Ellul's suggestions worth if we are are determined by something else than the efficiency calculus alone, namely the unending march towards greater entropy?

Here I would like to bring back into memory what precise role the PMEP oc-

14. Ellul, *Technological Society*, xxvii.

15. Ellul, xxvii.

16. Ellul, xxviii.

17. See also Rogers, 'Technological Society', 70–71.

cupies in Haff's technosphere. For Haff the technosphere acts as if to survive, and as the PMEP indicates, it will always move in the direction towards ever greater energy dissipation. But nowhere it is said that there is but a single way in which this purpose is achieved. Although the fundamental purposes of dynamic systems—in our discussion, the technosphere—are impossible to escape from, we should not understand them as completely determining, because they only provide the framework within which the particular behaviours in the technosphere unfold. In philosophical parlance, one could say that fundamental purposes are multiple realisable, that is, the purposes can be brought about in different ways. While the fundamental purposes indicate the *direction* of the system, they do not dictate the *path*. We may not be able to escape the conditions of the technosphere, but we are able to act within these conditions.

What this means then, concretely, is that we may not be able to shift the technosphere into directions that run counter to its intrinsic purpose of ever greater energy consumption, but if we take this constraint into account, we *are* able to set courses that *are* compatible with its intrinsic purpose. Even if the direction of the technosphere is fixed, the path is not. Because the PMEP is multiple realisable, Haff leaves a window of opportunity open for us to address the two main shortcomings of the technosphere qua geological paradigm, namely its lack of a conservative nature and its poor recycling (see section 4.1). Once we recognise that the technosphere has agency of its own, instead of being a set of neutral tools under our control (as the instrumentalists have it), we can see more clearly what steps we can best take to alleviate the ailments of the technosphere.

6.3 Towards new climate policies

Specifically, we may need to alter at least some of our climate policies. A natural first response to the climate catastrophe is to curb our energy use. Haff notes that it is indeed possible to tap into negative feedback loops of the technosphere in order to stabilise, say, the global temperature. But he also points out that controlling the Earth's temperature is not the same as controlling the system's metabolic rate. According to Haff, it will be very hard for humans to impose limitations on the global energy use, since it goes against the momentum of the technosphere of ever increasing energy consumption.[18]

But, and this is Haff's crucial point, 'energy use per se is not the problem.'[19] Recall that the outside perspective on the technosphere (section 4.1) shows that it is not the high energy use, but the lack of recycling that is causing the climate crisis. Climate warming is not a necessary consequence of high energy consumption. It is rather a consequence of a lack of adequate recycling mechanisms. Take the hydrosphere as an example: it consumes a thousand times more energy than the technosphere but recycles its own waste, namely fallen rainwater.[20] We may not be able to predict what will happen when the energy consumption of the technosphere increases further, but the high energy consumption alone does not imply that the Earth will become less habitable for humans.

Shifting policy focus from energy conservation to recycling waste has far-reaching consequences. Although providing an alternative climate policy is beyond the scope of my thesis, I will here briefly point out the implications for (1) geoengineering efforts, (2) renewable energy sources, and (3) climate activism.

Regarding (1), we should realise that geoengineering efforts have a better chance of succeeding if they are in agreement with the PMEP. Haff criticises some forms of geoengineering for failing to understand the momentum of the technosphere. For instance, there are geoengineering attempts that aim to cool the Earth by reducing the influx of solar energy. In one such proposal, this is achieved by launching a fleet of small spacecraft that deflect solar energy back into space.[21] Haff counters that such technologies go against the momentum of the technosphere, because they throw away usable energy. The very same technology could also be used to dissipate *more* energy: instead of deflecting solar energy that would otherwise have hit the Earth, we could use the spacecraft to capture solar energy that would otherwise have *missed* the Earth.[22] Instead of these kinds of proposals, that do not address the main shortcomings of the technosphere directly, we may be better off looking instead at initiatives for better recycling of (carbon) waste, since that *is* a main shortcoming of the tech-

18. Haff, 'Technosphere and Relation Anthropocene', 142–43.

19. Haff, 143.

20. Haff, 'Technology as Geological Phenomenon', 307.

21. See e.g. Angel, 'Cooling Earth with a Spacecraft'.

22. Haff, 'Technology as Geological Phenomenon', 308.

nosphere. Think for instance of geoengineering efforts that capture CO_2 from the atmosphere.

Regarding (2), it follows from the intrinsic purpose of the technosphere that the use of renewable energy sources does not automatically reduce the use of polluting energy sources, such as fossil fuels. Renewables like solar and wind energy increase the energy supply of the technosphere, feeding its increased metabolism. So there is a good chance that innovations like renewable energy sources will only lead to a significant *increase* in energy consumption, rather than *replacing* old (polluting) energy sources.[23] This is not to say that we should refrain from introducing renewable energy sources. After all, it is abundantly clear that we will need them in order fulfil the energy demand. What it does mean, however, is that the mere introduction of renewables *in itself* does little to alleviate the poor recycling of the technosphere. For that, we should tackle the sources of pollution, such as the fossil fuel industry, or more generally the present way in which capitalism is organised, in which negative environmental externalities are not taken into account.

This brings me to the final point. Regarding (3), strategies employed by climate activists may be more successful if they directly tackle the two shortcomings of the technosphere, instead of hammering on the importance of decreasing our human energy consumption. Again, the latter would go against the momentum of the technosphere and is therefore hard to achieve. What we need more, then, is activism along the lines of 'end fossil fuels now' and less along the lines of 'turn off the lights when you leave the room'.[24]

To conclude, Haff's technosphere opens up new avenues for climate policies which are not based on energy conservation—which is currently often the case—but rather on aligning our strategies with the built-in tendency of the technosphere to increase its metabolic rate. We are better off cooperating with the technosphere instead of fighting it—as many geoengineering and climate activist efforts still do.

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23. Haff, 307.

24. Then again, the current energy consumption of the technosphere cannot be sustained using only renewable energy sources. This makes a sudden stop of using fossil fuels extremely difficult. Still we *do* need a gradual run-down in the use of fossil fuels.

6.4 Repurposing the revised efficiency principle

We have seen so far that the asymmetry between human and technique poses existential risks (section 6.1), and that the kind of determinism advocated by Ellul and Haff (section 6.2) leaves us humans with some wiggle room to direct the technosphere towards greater sustainability, as we should (section 6.3). But how are we going to achieve this if our technical decision-making process is governed by an efficiency calculus? In order to answer this question, we will need to revisit Ellul once more. In this section, I will argue that Ellul himself does not provide us with a satisfactory answer to this question, but we may be able to repurpose his revised efficiency principle in the Anthropocene to solve the challenge.

Ellul himself seeks a way out of the technological society in his Christian theology. He proposes an ethics of non-power, in which we consciously decide *not* to do everything we are able to do with technique. In other words, he proposes a wilful setting of limits: we need to eradicate the pursuit of efficiency in order to form an alternative society.[25] Commendable as this solution may be to our individual well-being, in the light of the Anthropocene, turning our back on technique may lead to a situation in which we lose control even more. As Haff points out, our participation as components in the technosphere is not strictly necessary, and once we become obsolete from the technosphere's point of view, the technosphere may stop providing for us. The only way to prevent this is by continuing providing value to the technosphere, as I already discussed in section 6.1, but then we are back to square one, since we would continue to participate in the technical phenomenon, slave to the efficiency principle. An ethics of non-power may have worked in times were techniques affected only societies, not the Earth system at large, but that time is long gone.

Next to this fundamental problem with Ellul's proposed ethics of non-power, there is the *practical* problem of how to convince people to adopt such a stance. We have become so used to think in terms in efficiency, that any attempt to subvert the quest towards efficiency may be disposed of as backward and irrational.

So how can we make our techniques more sustainable, while the technical decision-making process is only justified by efficiency considerations? I propose

25. I cannot describe Ellul's theology here, but the basics of his ethics of non-power are explained in Ellul, 'Ethics of Non-Power' and Ellul, 'Search for Ethics'.

that we can achieve this in a far less radical way than Ellul's ethics of non-power. Whereas Ellul argues that we should reject the the pursuit of efficiency, the search for the 'one best way', I argue that we do not need to resist the efficiency principle. This way we can circumvent the objections I raised against Ellul's ethics of non-power.

As we saw in section 5.3, the revised efficiency principle stresses that it is not the *actual* efficiency calculus that determines whether a technical solution is accepted, but rather the way in which efficiency *justifies* its introduction. This means that humans are still very much involved in the technical phenomenon, because it is us humans towards whom the justification of the introduction of technical solution is made. If it is justification and not calculation that matters, it is conceivable that we can repurpose the efficiency principle for more sustainable ends, where we will start to accept technologies as efficient if they tackle the two problems of the technosphere. We could call it a sustainable efficiency. We must ensure that the 'most efficient way' no longer refers to the fastest, cheapest, easiest, but rather to the most sustainable, circular, renewable.

In a vocabulary closer to Haff's, we could say that the technosphere may become aware of its non-conservative nature, via its human components.[26] Once humans take sustainability into consideration when introducing new technologies, their conscious efforts may steer the technosphere towards a path that is more conservative and recycles better. Concretely, this means that sustainable technologies will be preferred over non-sustainable ones. Perhaps this may 'save' the technosphere, so that it becomes an established, rather than a failed geological paradigm.

Naturally, me advocating as an individual for a justification of technique based on sustainable efficiency is not going to have a discernible effect in the technosphere. After all, as an individual I am but a Stratum II component, unable to modify the Stratum III technosphere in any meaningful way. But one should not forget that I am not on my own. My individual ideas may influence others. As Haff writes:

> If enough humans climb on-board, the collective force of human resolve might be able to turn the trajectory of the technosphere in a direction more favourable to future human well-being.[27]

26. Haff, 'Technology as Geological Phenomenon', 304–5.

27. Haff, 'Technosphere and Relation Anthropocene', 142.

This is not to say that the process is going to be easy. We need to convince people that technical progress, while inevitable, is not immutable. Even within the technosphere—without the need of stepping out, as Ellul's ethics of non-power suggests—there are different alternatives available to us. But we need to open our eyes to these alternatives. We are so used to the idea of unstoppable technical progress, as present in almost all our political discourse (see section 5.2.4), that we collectively stopped seeing the alternatives. Only as a collective can we make a meaningful difference in the technosphere.

6.4.1 A regression towards instrumentalism?

Finally, there is one possible objection of my proposal of repurposing the revised efficiency principle that I want to address. If we are indeed able to repurpose the efficiency principle towards more sustainable ends, isn't that a regression towards instrumentalism, in which technology becomes a neutral tool again and we humans get to set the goals? After all, the whole point of Ellul's argument was that all human ends mentioned are adventitious to technical progress. Redirecting the efficiency principle, in our case in order to overcome the problems of the technosphere, seems 'compatible with the concept of efficiency which remains neutral, meaning that it can be applied and evaluated positively or negatively depending on the final cause', as Son rightly points out.[28]

I would like to respond to this objection in two ways. First, as Son observes as well, in order to truly use the efficiency principle in a neutral way, we would need to be able to calculate the efficiency of a given technology, in order to judge its net effects.[29] After all, only if we know the effects of a certain technology, we can judge from our (supposedly) neutral standpoint whether we should introduce it or not in order to do good. But since we can never know all the long-term effects of technical actions (see section 5.2.3), that calculation of effects is impossible beforehand. Ellul has shown that despite this impossibility, a technology is introduced nonetheless, because the effects that we *can* see always represents something positive. My suggested repurposing of the efficiency principle is emphatically *not* a new calculation of effi-

28. Son, 'Ellul's Efficiency Principle', 55.

29. See Son, 56.

ciency, since the very possibility of an efficiency calculus is impossible. Instead, it is a way to take considerations of sustainability into account when making a technological decision. Yes, the decision may still backfire, although we tried our best. But our taking sustainability into account will lead to different technological decisions, showing that even within technological societies, alternatives remain possible.

This brings me to the second part of my response. In my repurposing of the efficiency principle, I have so far looked at combatting the problems of the technosphere (lack of recycling and lack of conservative nature) as something that we humans need in order to keep the Earth inhabitable. But sustainable efficiency does not merely serve human ends; it serves technical ends as well. Not only humans benefit from solving the problems of the technosphere; the technosphere itself 'benefits' too. If the technosphere will move in a direction that is more sustainable, that is, where it will recycle its resources and does not threaten the continued existence of other geological paradigms such as the biosphere, this would serve its fundamental purpose of survival. After all, in the alternative scenario where the flow limits of Earth will be increasingly exceeded, not just *our* existence but also the existence of the technosphere itself is at stake. This is because the technosphere depends on other geological paradigms for its resources, and if these resources are depleted, it will cease to function. And if the technosphere would collapse, it would no longer be able to dissipate energy, so it would not act in accordance with the PMEP. With this brief remark, I would like to stress that the move to different climate policies, which I described in the previous section, is not just motivated by anthropocentric considerations of our own wellbeing, but also by considerations of the technosphere itself. In this case, the goals of humans and technosphere align, making successful repurposing of the efficiency principle more likely.

This brings me to my final point. In this thesis, I have shown that the technosphere has agency and its goals may be different than ours. But giving up the human monopoly on agency is not the same as dissolving human agency altogether. The principle of efficiency *obscures* our ability to modify technology, but it does not *preclude* it. We might not be fully in charge over technology, and our possibilities to modify technologies are limited, because we cannot overcome the technosphere's intrinsic purpose of survival. But nor have we become powerless creatures, surrendered to the mercy of our new technospheric gods. Within the constraints that the technosphere sets, there is still plenty room to negotiate. Just like we need the technosphere to exercise our freedom, as it provides us with the energy and tools, the technosphere needs us, as we can redirect its course to a more sustainable path.

CHAPTER 7
Conclusion

> *I'm a pessimist about probabilities,*
> *I'm an optimist about possibilities.*
>
> — Lewis Mumford[1]

In this thesis, I posed the question of technological and human agency on a technology-dominated Anthropocene Earth. I investigated how we can understand technology as having agency on its own, behaving in an autonomous way, and how that autonomy influences and diminishes our human agency. The latter question is important, because the current trajectory of the Earth is not favourable to human wellbeing, and we need to know to what extent humans are capable of responding adequately to the challenges of the Anthropocene: what response-*ability* do we have? Only after answering this question, we can consider questions of responsibility in the climate crisis. In this final section, I will first provide a brief summary of my argument and then draw my final conclusions.

In chapter 2, I first outlined how technology has played a role in the rupture from Holocene to Anthropocene. In the past few centuries, up to the industrial revolution, we experienced a Holocene calm, in which nature was relatively stable and at our disposal. The project of modernity thrived on the existence of a stable climate, favourable to human wellbeing. But as humans tried to gain ever more power over nature, nature started to behave in increasingly unpredictable ways. This started with the industrial revolution, but the rate of change increased greatly since the 1950s, mediated by technologies. I argued that the project of modernity fails to deal with the

1. Winfrey, 'Mumford Remembers'.

unpredictable consequences of technologies. Many new technologies lead to unexpected side effects, sometimes to the extent that the original benefits are completely negated—as we saw in the Jevons paradox. The project of modernity, with its privileging of human agency, led us to turn a blind eye to the explosion of nonhuman agencies on Earth, some environmental, some technical—but all interconnected.

In chapter 3 I looked at the different responses to the rupture that the Anthropocene represents. We are in need of a new response, because existing ones either double down on modernity despite its poor track record in dealing with the unexpected effects of technologies (ecomodernism), or believe in fairytales of returning to a pre-technological, 'pristine' Earth (ecocatastrophism). I proposed that we can find a more satisfactory response in the tradition of technological determinism, which reinterprets technology so that it is no longer a neutral tool (instrumentalism), but rather a phenomenon that has agency in itself. A common complaint against technological determinism is that it leads to fatalism. While indeed many texts by technological determinists are susceptible to a fatalist reading, I argued that it is possible to resist the fatalist pull. In fact, determinism offers us a more realistic outlook on technology, thus providing us with better handles for tackling the problems of the Anthropocene.

We first looked at what the technological determinists have to say. In chapter 4, I showed how geologist and physicist Peter Haff has thematised the role of technology on the Anthropocene Earth, providing us with a vantage point on technology. With his toolkit, borrowed from the systems sciences, we are able to understand how technology seems to serve our purposes, whereas really it serves its own intrinsic purpose of survival—like any complex system. Haff formulates a set of rules that govern the relation between parts in a complex system. For my research, I highlighted how these rules affect the relation between human and technosphere. The underlying principle driving the technosphere, according to Haff, is that of maximum entropy production (PMEP): the system acts as if to survive, constantly increasing its rate of energy dissipation until it runs into constraints.

I also pointed out a shortcoming of Haff's approach: he unjustly reduces humans to their physical system properties. This is problematic for understanding why some technologies are preferred over others, even if they all increase the metabolism rate of the technosphere. I argued that in this decision-making process, humans are still involved, even if their voice may not be the decisive one.

To make up for this deficiency and to see what roles humans play in the technosphere, I let Jacques Ellul enter the stage in chapter 5. His idea of the technical phenomenon is accompanied with a detailed characterology of technique. Eventually, all the characteristics depend on the efficiency principle, according to which modern technique is conditioned only by its internal calculus of efficiency. I considered criticism on this principle, in particular that Ellul's definition is incomplete and that historical evidence shows that efficiency is not the decisive factor in the development of technologies. I countered these criticisms by arguing that not the actual efficiency achieved is important in the technical phenomenon—because of the unpredictability of effects, we are not even in a position to calculate the actual efficiency—but rather the role efficiency plays as a justification for the introduction of technical solutions. Wha-Chul Son provides a similar argument. Under this revised efficiency principle, the criticism put forward no longer applies.

Finally, in chapter 6, I showed how we can resist the fatalist pull lingering in Haff's and Ellul's works. I showed that the authors identify existential risks with the determining character of technique, but also that these risks may be avoided if we recognise them clearly. Human agency is still present, because Haff's PMEP leaves room for us to decide *how* the technosphere's intrinsic purpose of survival is achieved, and because Ellul's story is ultimately a story of probability, not of inevitability.

I argued that we have an easier job dealing with the problems of the technosphere if we move with the momentum of the technosphere, instead of trying to fight it. Applied to climate policy, that means we should direct our efforts not so much to restraining our energy consumption, but rather to mitigating the non-conservative nature and poor recycling of the technosphere. Such efforts are possible, even within the technological society, because the efficiency principle has a justificatory role. If we succeed to redirect the efficiency principle towards a more sustainable form of efficiency, the goals of humans and technosphere may more closely align, benefitting both.

My final conclusion is that Ellul and Haff's presentation of technology as an autonomous phenomenon *obscures* our ability to modify technology, but it does not *preclude* it. Yes, technology has accrued tremendous agency in the Anthropocene, but recognising the agency of the technosphere does not mean that we have lost all ours. It is hard to let go of the human monopoly on agency—the ecomodernist movement is a case in point—but once we do, we can start *cooperating* with technological agencies instead of fighting them. It is possible to align the interests of the technosphere with our own. We may not be able to leave the path towards ever greater entropy production, but within this constraint, we are able to counter the problems that the anthropogenic impacts on the Earth system cause, at least in principle.

This is not to say that it is going to be easy. Great challenges lie ahead, not in the least in convincing other human to 'climb on-board' to moderate environmental pollution, as Haff calls it.[2] Precisely this becoming a collective force is necessary in order to exert our human agency over the technosphere, because the technosphere is indifferent to actions by individuals. But as an individual, I can influence the behaviour of others, by telling new stories about the Anthropocene and our role within it.

As I am finishing this thesis, it seems that people are increasingly joining this collective force. We find an example close to home: the A12 blockades in The Hague, organised by Extinction Rebellion in 2022 and 2023, have successfully led the Dutch parliament to pass a motion that calls on the government draft a plan for phasing out fossil subsidies.[3] While this may be a small step, to me it is proof that human agency is alive in the Anthropocene.

Will actions like these be enough to avert catastrophe? I am not sure. The aims of my thesis were not to show that we can easily prevent climate catastrophe. They were humbler; I merely tried to show that preventing such an event is *possible*. Although we have a long way to go, there *is* a path that we can walk. Despite the determining character of technology, we can still exert human agency as well.

2. Haff, 'Technosphere and Relation Anthropocene', 142.

3. RTL Nieuws, 'Blokkades A12 van de baan'.

Afterword: a brief reflection

I promise nothing complete; because any human thing supposed to be complete, must for that very reason infallibly be faulty.

— Herman Melville[4]

Finally, a note on the process of writing this thesis. As always, while doing research, one discovers an abundance of new sources to consider. My choice of main authors—Haff and Ellul—was motivated by their applicability to my research question, of course, but also by my prior familiarity with them. During my research, I became acquainted with the thoughts of an array of other authors, such as Langdon Winner, Bruno Latour, Lewis Mumford, Erich Hörl, James Lovelock, Andrew Feenberg, Bernard Stiegler, Kevin Kelly. At times, it made me wonder whether I had picked the right authors to address my research question. What if the shortcomings of the authors I had chosen were addressed by some other author? Then again, the act of writing is always an act of selection. One cannot say it all, even within the gracious word limits my university sets. It goes without saying that the story I told here is incomplete, but that is true for any story: it is as much about what you say as it is about what you *don't* say. When I found authors that had something useful to say about what I was discussing, I included them in the text, so as to prevent a selection bias where I would only include arguments that agreed with my working hypothesis. But naturally, many other authors missed the boat, their arguments remaining unheard within the confines of this thesis.

My story is but one of the stories one could tell about technology in the Anthropocene. I do hope that the story I told here was useful, cogent, and perhaps even a

4. Melville, *Moby-Dick*, ch. 32, §9.

little bit hopeful, considering the challenges of the Anthropocene we have yet to face.

APPENDIX A

Formulas

A.1 The Kaya identity

The *Kaya identity* is a mathematical tool developed by the ESS field for decomposing global emissions into its contributing factors. It is defined as

$$F = P\frac{G}{P}\frac{E}{G}\frac{F}{E} = Pgef,$$

where

- F: global CO_2 emission;
- P: global population;
- G: world GDP;
- E: global primary energy consumption;
- $g = \frac{G}{P}$: per-capita world GDP;
- $e = \frac{E}{G}$: energy intensity of world GDP (i.e., how much energy is used for a unit of production);
- $f = \frac{F}{E}$: carbon intensity of energy (i.e., how much CO_2 is emitted for a unit of consumed energy).[1]

Hence the global CO_2 emission is linearly positively correlated with the following four factors: global population, per-capita GDP, energy intensity, and carbon intensity. If we want to reduce global emissions, we must reduce at least one of these factors, in such a way that the other factors do not increase to the extent that the reduction is cancelled out.

1. Raupach et al., 'Drivers of Accelerating CO_2 Emissions'.
2. Friedlingstein et al., 'Global Carbon Budget 2022'.

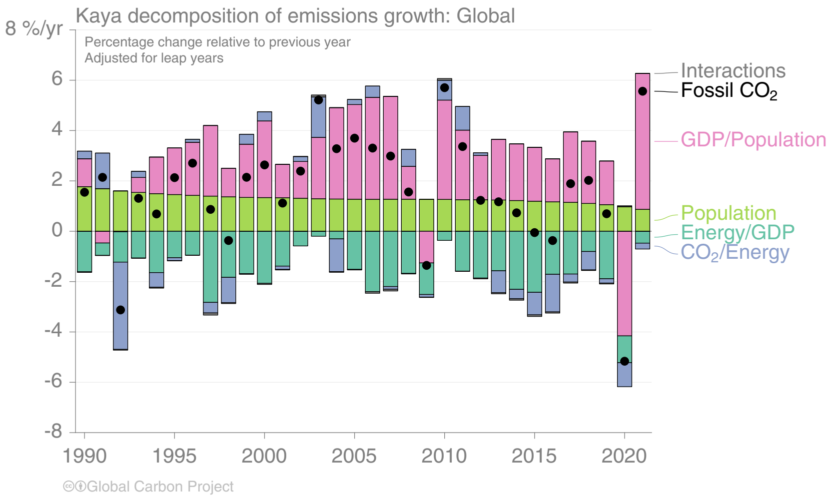

FIGURE A.1 Kaya decomposition of emissions growth from 1990 to 2021. Dots represent the net effect *F*.[2]

In the period from 1990 to 2021, carbon intensity of energy (*f*) and energy intensity (*e*) of world GDP have been decreasing. 'Good news', say the techno-optimists. But this effect is greatly offset by the positive effect of increasing consumption (*g*) as well as population growth (*P*). We see this in figure A.1, which presents the global Kaya decomposition of emissions growth for the mentioned period. The relationship between *ef* and *g* shows how rebound effects are at play: increased efficiency (in terms of lower carbon and energy intensity) is correlated with higher consumption.

Current policy efforts mainly focus on reducing energy intensity and reducing carbon intensity. Haff's technosphere teaches us that it may be more worthwhile reducing carbon intensity than reducing energy intensity.

A.2 The rebound effect

The rebound effect can be expressed as a fraction:

$$\text{Rebound effect } (RE) = \frac{\text{Rebound consumption}}{\text{Expected savings}} = \frac{\text{Expected savings} - \text{Actual savings}}{\text{Expected savings}}$$

[3]

Based on the fraction, one can distinguish five types of rebound effects:

- $RE > 1$: backfire effect, also known as *Jevons paradox*
- $RE = 1$: full rebound effect
- $0 < RE < 1$: partial rebound effect
- $RE = 0$: zero rebound effect
- $RE < 0$: super conserving effect

3. Wang, Han, and Lu, 'Energy Rebound Effect in Households'.

APPENDIX B
Haff's systems science: Six rules

B.1 Levels of description

In his paper 'Six rules', Haff applies the insights of systems sciences to the technosphere in order to analyse how technology functions as a geological phenomenon. In any complex system, different levels of description are available. Depending on the question at hand, we choose the most suitable level. The choice for a specific level of description determines which components of a system we can and cannot see. This process of adopting a particular level of description is called *coarse graining*.

An example where we apply coarse graining, is in the analysis of road traffic. It is possible to coarse grain at the level of the components of a car, describing what they are made of and the way they are bolted together. But we can also coarse grain to a higher level of discrete cars, where we abstract away from the details of each specific automobile. Or we could coarse grain at a higher level still, where we only look at traffic density; here only the collective effort of automobiles remains visible. For optimising the timing of traffic lights the intermediate level of description of discrete cars is most convenient, whereas for investigating regional traffic flow, we may prefer a more abstract density description.[1]

For the technosphere, being a complex system, we can also use coarse graining. This allows us to zoom in or zoom out on technology at will. Let's say we coarse grain at the level of some system *S*. We can then indicate three levels or *strata* relative to *S*. Systems that are at the scale of *S*, that is, systems that have a similar size, occupy Stratum II. *S* itself occupies Stratum II as well. Components of *S* that are much smal-

1. Example after Haff, 'Six Rules', 129.

ler than *S* occupy Stratum I. Finally, components that are much larger than *S* occupy Stratum III. *S* then is a component of these Stratum III systems.[2] It is vital to note here that Stratum I, II and III are always defined *relative to* the scale of system *S*. If we choose a different system *S*, the strata change accordingly.

An example. Say *S* is a human. Stratum II systems are for instance fellow humans. Blood cells, as well as other small-scale bodily components, occupy Stratum I. And the city that *S* lives in, or the university *S* attends, occupy Stratum III.[3] In figure B.1 I visualise an example of different strata.

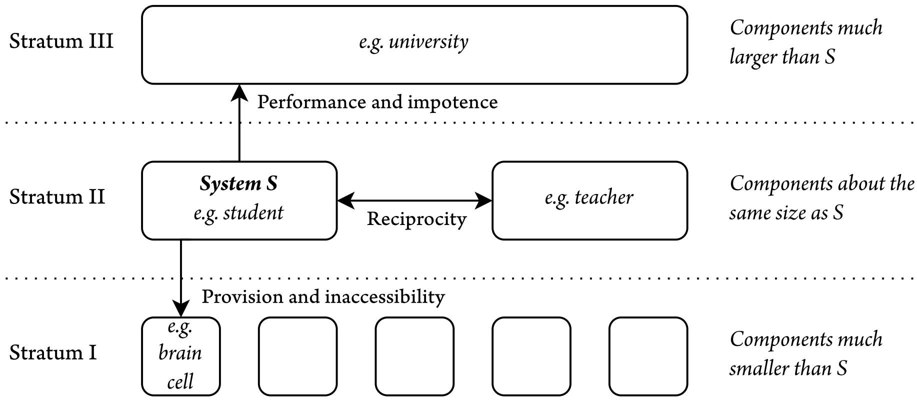

FIGURE B.1 Three-strata picture and rules governing relations between systems and components.

B.2 Six rules

Haff applies the three-strata parsing scheme to develop six rules that govern the relationship between different systems, or between a system and its parts. These rules can then be used to understand the relationship between humans and technology in the technosphere.

Inaccessibility The rule of inaccessibility states that a system does not have *direct access* to lower-level Stratum I components. For the technosphere, this means that it cannot directly affect *individual* people at the lower level. It is still possible to influ-

2. The three-strata picture presented here is similar to the biological concept in Salthe, *Evolving Hierarchical Systems*, 57.

3. Example after Haff, 'Six Rules', 130.

ence lower-level components on a larger scale, but that process is imprecise. Just try lifting a single organic cell of a leaf on the ground. You will only succeed if you lift the whole leaf. And the whole leaf is a Stratum II system, not a Stratum I system.

There is however a way in which *indirect access* to Stratum I components is possible. Strata are not congruent; they may overlap. So it is possible that some system is *both* within *S*'s Stratum II and in the Stratum II of some smaller system which *S* cannot directly manipulate. An example may clarify this. While we cannot pick up a single organic cell, we *can* use a microscope equipped with a manipulator arm. The microscope is in our Stratum II and we can use it to control the manipulator arm that picks up an individual cell, which is *not* in our Stratum II, but *is* in the Stratum II of the manipulator arm. The microscope is part of a chain of overlapping strata which makes indirect access possible, the chain being human–arm–hand–finger–microscope–manipulator arm–cell.[4]

Impotence The rule of impotence goes in the other direction: a Stratum II component cannot influence the higher-level Stratum III system. This is in fact necessary for the survival of the system. Imagine if a single component did have that influence: then the whole would become very unstable. For instance, if a single complaint by an individual would overthrow the policy of a bureaucracy, the continued functioning of that bureaucracy would be threatened. In the context of the Anthropocene, this rule explains why technology seems to resist interference from humans.

Control In some systems, there are components that can nevertheless exert significant influence at a higher level. This is the rule of control. For example, a captain (Stratum II) has great influence over the navy ship (Stratum III). This is possible by virtue of a carefully designed chain of command, which is a series of overlapping System II levels.

In the case of the technosphere, Haff believes that there is no such leadership infrastructure. It is not a designed or engineered system, but rather an emergent system, as we saw before. The metaphor of Earth as a (space)ship is therefore misguided, because the Earth system has no captain.

4. Example after Haff, 'Six Rules', 130.

Reciprocity The rule of reciprocity entails that two systems that are in each others' Stratum II may influence each other directly. This is a corollary of the rules of inaccessibility and impotence.

Performance According to the rule of performance, at least some components at a lower level must support the system at a higher level. If too many components fail, the system would not function. In the context of the Anthropocene, this means that most humans must support the functionality of the technosphere. They do so by holding a job, reproducing, sharing knowledge, etcetera.

Non-functioning parts may be penalised. If one is unable to work, he or she is at risk of becoming homeless. From the perspective of the technosphere, they are broken parts that may as well be discarded.

Provision Finally, the rule of provision states that the Stratum III system provides a suitable environment for its Stratum II components. The technosphere provides human parts with food, fresh water and medication, as well as the knowledge to perform our jobs and the leisure time to consume effectively.

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Summary

The advent of the Anthropocene confronts us with an illusion. Humans appear the most powerful agents on Earth, but we seem unable to mitigate anthropogenic effects on Earth.

To understand this illusion, I investigate the role of technological agency in the Anthropocene. I formulate a technological determinism based on Jacques Ellul and Peter Haff, which captures the physical role of technology on Earth.

From their combined work, a novel perspective on technology emerges, which allows us to better understand how technological and human agency relate to each other. I argue that human agency has not disappeared, but we do need to change our strategies, working *with* instead of *against* the momentum of technology.