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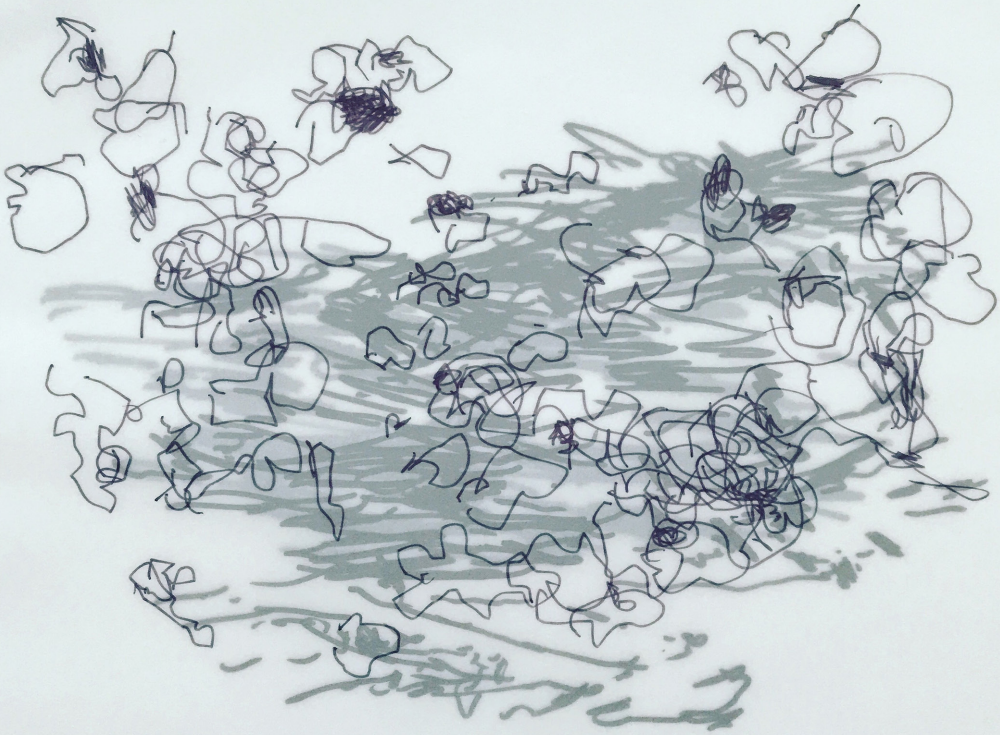

STS Italia Conference 2023, Bruno Latour, Patenting Biomedicine, Border Technologies

Bark, Gum, Garbage bins (citizen shadows series) (2018) by Linda Knight

The pernicious nature of colonisation enacts ongoing effects on communities and environments that have experienced life in its many contact zones, including the invasion of lands, extractive-related damage to land and water ecologies, and socio-interventionist policies. Creating artistic commentary about the scale of these effects can be important for developing a decolonial practice that is committed, critical and generative. Through an experimental cartographic approach called inefficient mapping and via drawing and critical stitching practices, Linda Knight explores how experimental cartographies help to create counter-narratives of colonisation across its many contact zones.

Rather than a human wandering about in spaces and taking notice of things to draw, *inefficient mapping* provokes thinking differently about the ethics of the encounter and of being human, of the coloniser who has fenced off, stolen, fought for, hunted on, farmed, listened to, birthed on, hacked up, planted into these spaces and keeps that central during the process of wayfinding.

In the citizen shadows series, Knight conducted a citizen census of the urban citizenry in Brisbane, Australia via thirty small, in-situ mappings recorded over the duration of a month. The shadow; ubiquitous to each citizen, whether solid, liquid, or gas, was the common factor Knight mapped to conduct the census. The citizen shadows series experiments with the speculative possibilities of establishing a more-than-human civics, and how this might be actualised.

An Associate Professor at RMIT University, Australia, Linda is an award-winning, internationally recognised artist and scholar. Linda is the Founder and Director of Mapping Future Imaginaries, an international group of artists, creatives, scholars, and industry specialists exploring ideas about our future lives and the world.

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STS Italia Conference 2023, Bruno Latour, Patenting Biomedicine, Border Technologies

Cover *Bark, Gum, Garbage bins (citizen shadows series)* (2018), by Linda Knight

The Role of Patenting in the Valuation of Biomedical Innovation

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Abstract
Intellectual property rights (IPR), and patents in particular, play a central role the commercialisation of new knowledge and techniques in the life sciences. In this paper I examine the shaping effect of patents and patenting on the innovation trajectories of three emerging biotechnologies: gene editing, induced pluripotent stem cells, and 3D bioprinting. All three are examples of "biomodifying technologies", that is, tools and techniques that permit human intervention in, and modification of, fundamental biological processes, and each has been subject to varying degrees of patenting activity. The analysis draws on the sociology of valuation to position patents as both the outcome of particular practices of valuation and as entities that are themselves folded into other practices for calculating value in the life sciences economy. Drawing on qualitative interviews with a range of stakeholders including academic and clinical scientists, representatives of companies whose commercial activity incorporates one or more of these technologies, and actors involved in other ways with the governance of these technologies such as intellectual property experts and employees of university Technology Transfer Offices (TTOs), I show how "upstream" market considerations inform strategic assessments of what is worth patenting and how patent claims should be drafted.

Keywords
patents; value; valuation; biotechnology; innovation.

1. Introduction

The concept of "biomodifying technologies" was developed to account for particular type of technique, developed through life sciences research, that enables scientists to modify living biological tissue in a directed fashion (Morrison et al. 2019). Historical examples include cell culture, recombinant DNA (rDNA), the polymerase chain reaction (PCR), hybridoma technology for creating monoclonal antibodies, and somatic cell nuclear transfer ("cloning"). Biomodifying technologies typically arise from molecular and developmental biology; fields dedicated to exploring the "plasticity of biological life" (Landecker 2010). They are at once "transformative" in that they extend and enhance scientists' capacity to manipulate and alter living biological

material, and simultaneously "domesticated" in that they belong to a familiar "genre of technique" (*ibid.*) within the life sciences (c.f. Martin et al. 2020). Unlike the early caution attending biomodifying technologies like rDNA, contemporary biomodifying technologies are subject to rapid commercialisation and efforts to "translate" them into new products and services, as is now common for life sciences research (Maienschein et al. 2008; Morrison and Bartlett 2022).

The project "Biomodifying technologies and experimental space: Organisational and regulatory implications for the translation and valuation of health research" examined three contemporary biomodifying technologies: induced pluripotent stem cells (iPSC), gene editing, and 3D printing of biological material. "IPSC technology" refers both to the method of producing the cells by chemically "reprogramming" adult somatic cells to an embryo-like, pluripotent state, and to the iPS cells themselves, which can be chemically induced to become many different types of body cell (lung cell, nerve cell, heart muscle cell et cetera). Gene editing tools, of which CRISPR/cas9[1] is currently the most prominent example, contain a programmable "targeting" domain that can be designed by scientists to find and attach itself to a particular sequence of genetic material in a living cell, and an enzyme that can cut out that particular piece of the DNA, replace it, or change its content (for example, changing an "A" to a "T" in the genetic code). 3D bioprinting is a manufacturing technique which can be applied to many different cell types, including iPSCs. It is a form of additive manufacture where complex three-dimensional constructs are produced via deposition of fine layers of material one on top of the other (Mironov et al. 2008). Bioprinting adapts additive manufacture techniques by replacing plastic or metal as the material to be 3D printed with gel-like suspensions containing living cells, known as "bioinks". The goal is to "[...] transfer the precision, flexibility, speed and agility offered by 3D printers to clinical applications in order to recreate highly complex and heterogeneous structures" (Lafontaine et al. 2021, 557).

To keep the project manageable and coherent over the three case study technologies, the project team (see *Acknowledgements*) opted to focus exclusively on attempts to develop these technologies for human biomedical application. The project, and this paper, do not consider the various plant or animal related applications of gene editing, bioprinting or iPSC. Our investigation of biomodifying technologies was structured around three questions:

- RQ1) How can the "experimental space" which these technologies currently occupy be characterised and what does this mean for translational health research and its likely trajectories?
- RQ 2) What are the challenges and risks posed by these technologies for existing, legal, regulatory and governance regimes?
- RQ3) What is defined as their benefit or value and how is benefit and/or value assessed?

My focus here is the project's first and third research questions[2], which are connected. The "experimental space" for each of the three case study biomodifying technologies maps, to a greater or lesser extent, onto the existing socio-technical system (Geels 2002) or techno-economic network (Callon 1990) of (medical) biotechnology. It is within this space that technology development occurs and innovation trajectories are shaped:

> Research is conducted by public laboratories, universities, private firms (small, medium and multinational), non-profit organizations and health-care facilities (public and private).

> It is funded by taxpayers, philanthropic foundations, private investors, companies and patients. And it is shaped by public policies and agencies, such as those for intellectual property (IP), regulatory standards, procurement, treatment guidelines and reimbursement. (Swaminathan et al. 2022, 207).

The connection between this understanding of the experimental space for biomodifying technologies, and the issue of how they are given value (and for and by whom) lies in the contention that the shaping of the innovation trajectories of biomodifying technologies, by the institutions, markets regulations, laws et cetera described above, can be understood and analysed through the lens of valuation.

Specifically, this strand of the project (RQ3) draws on work in Valuation Studies which treats value not as an inherent property of things, nor as a mere signifier of, e.g., social class, but *as the outcome of practices of valuation* (Muniesa 2011; Dussauge, Helgesson and Lee 2015). "Value" here is also understood in the sense of "worth": what is worth doing, having, being, knowing, et cetera. This encompasses multiple forms of merit (moral, cultural, epistemic and so on) and is not limited to economic value or cost. Contemporary biomedical innovation is subject to a plethora of assessments and valuations, including, but not limited to, those listed by Swaminathan et al. (2022) above. Many, though not all of these nodes use institutionally-embedded, formal tools and methods for calculating value or worth, which Valuation Studies describes as "devices". Translational research with biomodifying technologies may be animated by promise (Borup et al. 2006), but I argue that its trajectories and outcomes are steered by the cumulative (inter)actions of these disparate, but durable, practices and devices for valuing innovation.

Considering the "experimental space" in its entirety and all the forms of valuation it contains cannot be reasonably set out within the confines of a single paper. Elsewhere, project members have analysed how academic and commercial researchers working with biomodifying technologies identify what makes a "good target" for translational life sciences research (Morrison and Bartlett 2022). That analysis concluded that "translational" scientists anticipate the ways in which the value of their proposed work will be assessed by a variety of audiences (peers, funders, managers, journal editors, regulators, clinicians etc.), each deploying their own criteria and metrics of worth. Scientists' choices of which research is worth pursuing results from attempts steer a course that is likely to demonstrate at least adequate merit to each of these different groups. In other words, embedded practices for valuing translational science shape what comes to count as "good" or worthwhile research. In this paper, I extend this frame of analysis by examining patenting as another node within the experimental space for biomodifying technologies where they are subject to a particular form of assessment or valuation (the patent application) and where the outcome of that valuation in turn shapes the innovation trajectories of each technology. None of this is meant to imply that patenting is the only, or even the most important, site at which such technologies are valued. A granted patent cannot be taken as a measure of economic value or indeed of societal need for an invention. For example, Lehoux et al. (2014, 1026) report that in the medical devices sector almost half of all patent filings do not lead to any marketed product. Nonetheless, each of the three biomodifying technologies studied here has been subject of considerable patent activity

(Bicudo et al. 2022; Bicudo et al. 2021a) and it remains an important part of the story of how biomodifying technologies are valued and how their development is steered.

2. Patent examination as valuation

What does it mean to view patents and patenting through a lens of valuation, and can such an approach be justified? Valuation refers to "any social practice where the value or values of something are established, assessed, negotiated, provoked, maintained, constructed and/or contested" (Doganova et al. 2014, 87). This encompasses all forms of examination, testing and assessment as well as judgements and calculations. Importantly, "value" in Valuation Studies is not limited to economic value or price. Focusing on how people calculate and justify what is worth doing, having, being, knowing and so on, provides a way to consider economic value (usually considered quantitatively) alongside cultural and moral etc. values (usually considered qualitatively). This is not to imply that economic value in some way "is" cultural or vice versa. Rather, both "value" and "values" "denote the desirability of certain acts over others, and both refer to the collective production of that desirability and its governing effect on individual actions" (Dussauge et al. 2015, 9). This approach allows "valuation"-based analyses to consider multiple registers or grammars of worth, which can intersect, combine or oppose one another, without reducing one kind of value to another.

From this perspective, even an uncritical "face value" account of patent filing and examination shows that it clearly entails valuation. National patent offices form an obligatory passage point for anyone seeking a patent, and constitute an institutional site of valuation. The United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO) are the most globally significant patent offices (Parthasarathy 2017)[3]. In order to transform a piece of scientific knowledge or know-how, it must first be parcelled out and transformed into a set of one or more claimed "inventions". This is the task of patent attorneys who write patent applications, known as filings. The key criteria for assessment are: novelty (is the "invention" in some way distinct from what is already known), non-obviousness (did it require an "inventive step" to produce), and that it has utility or "industrial application". Patent offices also operate on the principle of "priority"; that is the first party to file a claim has the right to intellectual property rights on that invention, even if they were not necessarily the first to identify or produce what is being claimed. In addition, many types of "invention" are excluded from patentability such as varieties of animals and plants, computer software, the human body, and any elements of the human body derived from "simple discoveries". The EPC also contains prohibitions on granting patents in inventions whose exploitation is deemed to be contrary to morality or "ordre public"[4].

Lamont (2012) identifies several sub-practices that can go into making a valuation including classification, comparison and ranking of entities. In the process of examination, patent filings *are* ranked (who filed first and thus has priority?) classified (do the claims made fall into the acceptable or prohibited categories of invention?) *and* compared (is the claimed invention suitably distinct from what has gone before?), and therefore evaluated. This kind of institutionally embedded, standardised rules for *what* should (and should not) count and

be counted, *how* worth should be calculated or judgements reached, and often what format *outcomes* should follow can be considered as a "mode of valuation": "a particular manner of assessing and attributing the value of something" that is both adaptable and situated in concrete practices, metrics, categories and reference points (Hauge 2016, 127).

Scholars in STS and elsewhere have produced more detailed, more critical accounts of patenting, which recognise that patenting a piece of scientific knowledge or know-how is an act of translation, in the sense envisioned by Callon (1984). It is an attempt to impose a particular order and meaning on events (usually experimental findings and artefacts) by enrolling disparate human and non-human actors into a particular set of roles. In this case, this ordering partly takes place via the construction of texts in the form of patent filings which:

> [G]ive internalist and Whig accounts of the development of the process or apparatus that they describe, and as legal instruments they attempt to impose that interpretation on the material world. (Bowker 1992, 53)

As with any attempt at translation, a patent filing can fail, and even "success" is only a temporary stabilisation that can be undone by subsequent litigation. Bowker's (1992) account of patent litigation makes clear that criteria such as "priority" and "novelty" are produced by considerable behind-the-scenes work that is rendered invisible in formal patent filings or court battles, and that their validity is not inherent, but a local and contingent achievement. However, while these critical accounts add further layers of nuance and complexity to our understanding of the processes involved, they do not invalidate the fundamental idea of patent assessment as a series of formalised, institutionally-embedded valuations.

3. Folded valuations and the many uses of patents

Patents may be the outcomes of a process of valuation, but once granted they are themselves valued, and of value, in a number of different ways. This recursiveness is a repeated motif of valuation; for example, Helgesson and Lee note that "[a]ll experimental designs can be seen as both the outcome of valuations and as devices for performing valuations" (2017, 9). The idea that different valuation practices can be interrelated, and that what counts in one case can impinge on or drive what is counted, or how value is calculated in another setting is known as "folding" (Helgesson 2016). Patents confer a monopoly right, granted by the state, to exclude others from using an invention or to set the terms, via a licence, on which that invention may be used. Many arguments have been put forward about the justification and purpose of patents; that is about why such a monopoly right is *worth* permitting. These include the idea that they are "natural rights" resulting from the labour of an inventor, that they facilitate a right to self-development through creativity, that they act as a "just reward" and thereby a stimulus for innovation, that they provide a method of maximising utility of inventions, or that patents minimise wasteful duplication of effort by assigning control of the future development of a technology to a single party (Papaioannou 2006; Panagopoulos and Sideri 2021). STS scholars have also considered the value of patents as rent generating

assets (Birch 2020), as tools that facilitate their holders to secure entry to markets and send positive signals to capital investors (Lehoux et al. 2016), and as a means to shape the wider socio-technical systems through which new technologies develop (Hilgartner 2009). These are all examples of folded valuation practices; what is of analytical interest is not merely that they happen but their effects and consequences. For example, in the case of patents, we can ask whether anticipation of market valuations folds into decisions about what gets patented in the first place or how the claims in patent filings are drafted, and if so with what effects?

This understanding of patents as both the outcome of valuation practices and as entities folded into other practices of valuation within the experimental space, provides a conceptual framework for interrogating the shaping effect of patents and patenting on the innovation trajectories of biomodifying technologies, which is the overarching aim of this paper.

4. Methodology

The Biomodifying technologies project ("BioMOD") ran from 2017-2021 and employed a range of methods: review of academic and grey literature (government reports, company websites etc.), legal and regulatory analysis, quantitative data collection and qualitative interviews. The legal and regulatory analysis was partly supported by a separate grant from the Leverhulme Trust and has been presented elsewhere (Mahalatchimy et al. 2021; Mourby et al. 2022; Lim and Li 2022). This second project, "Governing biomodification in the life sciences" ("BioGOV") ran from 2018 to 2022. Both projects were collaborations between the universities of Oxford, Sussex and York in the UK and both examined the same three "biomodifying technologies". Mapping the experimental space was an iterative process of identifying key actors from the literature, conducting qualitative interviews, and often identifying further documents, events and actors from information provided by interviewees. Based on the project team's prior knowledge of biotechnology, it was recognised at the outset that this would include actors such as university Technology Transfer Offices (TTOs) and patent attorneys. It is important to note that a comparative analysis of the overall patent landscape of patenting for the three case study biomodifying technologies, which presented both qualitative and quantitative data, has already been published elsewhere (Bicudo et al. 2022), as has a more detailed look at the specific case of IP in bioprinting (Bicudo et al. 2021a). Equally, this was not a project exclusively, or even mainly, about intellectual property *per se*, so interviewees were selected to cover a range of stakeholders including academic and clinical scientists working on translational research with one or more case study technologies, representatives of companies whose commercial activity incorporates one or more of these technologies, representatives of UK regulatory agencies, and intellectual property experts and representatives of university. This reflects our framing of the experimental space, and while most interviewees were asked about their activity in relation to patents, questions about patents were only a limited part of a larger set of interview questions designed to get interviewees discussing the ways they evaluate their work and the ways in which they, and their work, is in turn evaluated, justified and measured.

Interview questions were tailored to different types of interviewees and patent professionals were included as part of the subset of interviews with questions designed for regulatory

and regulatory-adjacent actors. The number of interviewees of different types is summarised in Table 1 below. The full set of question schedules for BioMOD interviewees is available from the UK Data Service (study number 855143). The DOI is linked at the end of the manuscript. Patent attorneys, like most other regulatory interviewees were reluctant to discuss specific instances of regulating particular biomodifying technologies, usually because such details are confidential. As a result they tended to respond to questions with illustrative generalisations or examples from other well-known technology fields taken. However, this does not necessarily limit the validity of the data presented here because most systems for regulating biomedical innovation are themselves technologies of commensuration that act to make a wide range of technology-based products amenable to valuation through a single set of devices. Medicinal products regulation is a partial exemption as special regulatory categories already exist for cell or gene based therapeutics, but Health Technology Assessment and Intellectual Property Rights both aspire to fit biomodifying technologies into the remit of their existing categories, standards, and methods of assessment and valuation. Rather than regarding this as a limitation, it arguably increases the legitimacy of treating the analysis of biomodifying technologies a window into wider processes of patenting in biotechnology.

The majority of interviews were conducted in the UK by members of both project teams. The full list of project members who contributed interviews is given in the *Acknowledgements*.

Interview type	Number of interviews	Source Project
Academic or clinical scientists working with gene editing	9	BioMod
Companies involved with gene editing	7	BioMod
Academic or clinical scientists working with iPSC	9	BioMod
Companies involved with iPSC	7	BioMod
Academic or clinical scientists working with 3D bioprinting	16	BioMod BioGov
Companies involved with 3D bioprinting	9	BioMod BioGov
Representatives of regulatory bodies	13	BioMod BioGov
Other governance actors including intellectual property experts and representatives of university TTOs	14	BioMod BioGov
TOTAL	84	

Table 1.
Number of interviews per category.

Research ethics approval for the UK interviews on both projects was obtained from the University of Oxford Social Sciences and Humanities InterDivisional Research Ethics Committee. For BioMod, additional approval was obtained from the University of York ELMPS Ethics Committee. For BioGOV, a preliminary set of interviews with 3 academic and 3 commercial

3D bioprinting developers was conducted in Brazil as a way to supplement the limited number of bioprinting interviewees identified in the UK. Research ethics approval for these six interviews was obtained from the Research Ethics Committee of King's College London, as this was the institutional location of the project member conducting these interviews at the time.

Written informed consent was obtained from all participants prior to the interviews. Interviews were a mixture of in-person, online and telephone interviews and typically lasted between 40 minutes and 1 hour although a few were longer. All interviews were audio recorded except in a small number of cases (n = 3) where interviewees declined permission to be recorded and in one instance the digital recording function failed. These interviews produced only notes made during and immediately after the interview. Audio recordings were transcribed using a professional transcription service operating under a confidentiality agreement. Text from each interview transcript was assigned to broad codes based on pre-determined areas of interest defined by the projects' aims such as commercialisation of each case study technology, business models, patenting practices, and experiences of securing investment et cetera. Within these broad codes, data was inductively analysed to identify themes and patterns in interviewees' responses, in particular those relating to justifications for particular choices and courses of action, and accounts of which activities or entities were worth pursuing, owning, doing, having et cetera. The results reported below mainly derive from material at the intersections of the codes "patents and patenting" and "value and valuation" as assembled by the author.

5. Results

5.1 Characteristics of patenting in the experimental space for biomodifying technologies

Induced pluripotent stem cells, and gene editing, which in our study included tools such as Zinc Finger Proteins (ZFN), TALENS, and CRISPR/cas9, hew most closely to the established socio-technical system of biotechnology innovation. In each case there is a "foundational" new technical capacity – either a method of modifying DNA like CRISPR or the method for chemically "reprograming" isolated skin or hair cells to an embryo-like pluripotent state which is patented. Each initial patent was followed by a rapid growth in the number of filings and the number of applicants. Of the three biomodifying technologies, gene editing has by far the largest total number of patent filings and the fastest growth in number of filings (Bicudo et al. 2022). This is largely propelled by the vast popularity of CRISPR compared to other methods such as ZFN or TALENS (Bicudo et al. 2022; Zhou et al. 2021)[5]. IPSC exhibit a more modest patent estate and the slowest rate of new filings of the three technologies. This, Bicudo et al. suggest "is arguably signalling greater anticipated difficulty in commercialising applications of iPSC technology beyond its current use as a tool in preclinical drug screening" (2022, 6). 3D bioprinting is the most unique of the three biomodifying technologies. Bioprinting necessarily involves a range of elements: a bioprinter, bioinks, Computer Aided Design (CAD) software, Computer-aided manufacture (CAM) software (which translates CAD design files into printer instructions), and biomaterials to provide structural and chemical support for printed con-

structs (Bicudo et al. 2021b). There is no obvious "foundational" patent since the techniques of additive manufacturing originated in other sectors, initially for use with plastic or metal. Bioprinting has the fewest filed patents of the three biomodifying technologies but the number of filings is growing faster than that for iPSC suggesting a growing market (Bicudo et al. 2022).

Regardless of whether "foundational" patents derived from public or private sector research, as the number of patents in each field of biomodifying technology R&D increases so does the predominance of private sector patent holders:

> In the three domains, companies hold over 50% of the patents, a proportion that reaches around 65% for bioprinting. (Bicudo et al. 2022)

Despite being heavily commercialised, bioprinting also has a greater geographic diversity of small start-up bioprinting companies compared to the gene editing which tends to be dominated by US and European firms including many large incumbent companies holding large patent estates (Bicudo et al. 2022; Bicudo et al. 2021b) The situation with iPSC is similar but with a higher proportion of patents held by Japanese universities and firms, as iPS has been the subject of considerable national investment in Japan (Mikami 2015). While provision of gene editing and iPSC tools, equipment and reagents has been largely the province of incumbent life sciences supply firms, there is also a flourishing academic community using "open source" software for bioprinting and in many cases also building or modifying "in-house" bioprinters rather than buying "off the shelf" commercial products (Bicudo et al. 2021b). This however, is something of an exception.

5.2 The mode of valuation in patent assessment and its effects

The key to understanding this pattern of patenting is to recognise biomodifying technologies as platform technologies. While the promise around biomodifying technologies tends to emphasise the potential for new therapies, the first and largest market is as tools to be used in further research and development. To develop clinical applications of each biomodifying technology requires significant additional technological development, refinement, and advances in supporting technologies (e.g., cell culture media with no animal by-products, bioreactors etc). This in turn creates significant scope for patenting each of these subsequent steps and developments, as both novel and having their own, additive "technical effects". One IP expert explained the relevance of how the "utility" requirement is interpreted by patent examiners in the following way:

> The way the European Patent Office has evolved its law and its practice over the years is to interpret that as requiring some form of technical effect that can, at least in principle, be translated into something useful. The US law uses the concept of usefulness a little bit more but I think it comes to the same sort of thing. (Intellectual property expert interview 3#)

This "technical effect" approach to utility constitutes part of a particular "mode of valuation" practiced by examiners in patent offices. The traditional scientific metric of evidence,

here experimental evidence for what is being claimed, is translated into a legal one, in this case the "reasonable expectation" of a future application. The particular configurations of valuation practices matter because they have consequences. The ways in which the "novelty" and "technical effect" criteria are defined and assessed facilitate, and arguably help to incentivise, the fragmentation of a particular piece of research into multiple separate claims and patents. Specifically, the idea of "technical effect" frames the "patentable matter" as any functional element, rather than as a fully-operational device or process. What is patented is not for example "an iPS-derived neuronal cell therapy for Parkinson's disease" but the design for the functioning of a particular component within one of these devices. This allows complex devices and procedures to be broken down into multiple patentable elements, even if the utility of the device in the everyday world derives from the whole product not its isolated components:

> You've got a mobile phone sitting there or your recorder that's sitting there and you've probably got dozens of patents, if not sometimes hundreds of patents, that are involved in... [...] you can't make a mobile phone out of just one of those patents [...]. You've got lots of different aspects of it, each one of which could be separately patented, I suppose, as long as it fulfils that requirement of having something about it that's technical and not just abstract. (Intellectual property expert interview 2#)

With platform technologies like iPSC gene editing and bioprinting all being enrolled into translational endeavours to develop them as components of future complex products and services, this fragmentation has the twin effects of giving "upstream" patents with broad product claims such as those the main gene editing tools or on induced pluripotent stem cells significant value, whilst leaving considerable space for further innovation, which in turn leaves room for new patent applications and thereby new actors to enter the market for developing these technologies. The multiple ways in which patents are valued, and the way these practices fold back into decisions about what to patent are explored in the next section.

5.3 How patent valuation criteria drive strategic behaviour in patent filing

As the total number of patents relating to each biomodifying technology, and subject matter for each they cover, accumulates in a particular technology field, new prospective patent applicants and market entrants must also take care not only to identify and protect what is novel to their own attempt to commercialise some aspect of the technology, but also to check whether, and to what extent what they want to do is covered by intellectual property rights already held by other parties. In patent practice, securing a proposed area of activity that does not fall under the remit of one or more existing patent holders is known as "freedom to operate" (FTO). This is a direct consequence of the fragmentation of complex products into many patent claims facilitated by the mode of valuation of patent offices, but it also fosters a range of modes of valuation treat patent filing as an instrument for strategic gain (rather than, for example, a "just reward" for innovation or a mode of personal expression[6]).

Consider the practices of patent attorneys in writing filings; construction of these texts is part of the attempted translation of experimental data and artefacts into a particular order

and meaning (Callon 1984) but they are also actions in a particular mode of valuation (Hauge 2016). Patent attorneys make choices and write patent claims in a particular way in response to, and as a way of enacting, particular value imperatives that are part of their professional role. Importantly, the judgements they are making are less about a "naïve" consideration of whether or not the scientific subject matter meets the criteria of novelty, non-obviousness or utility and instead revolve around calculations of future markets and strategic advantage over competitors.

> [I]n general, the job of the patent attorney is to get as many different types of claim as possible so that one way or another you are going to be able to trap an infringer or encourage people to stay off the market. (Intellectual property expert interview 1#)

Some of the "value maximising" techniques are discussed in the following quotes from current or former patent attorneys:

> If we get somebody in who say "I've done this, 'A', and I think we could do 'B' as well but we're not sure, we haven't done it yet", what you can do is file twice, "A", one specification with what you know is right and another specification on the same day which has some extra information that you're not sure about. Then at 12 months you can say which one shall I take. I'll take "B". You can do the same if you're not sure about... you can file two [...]". (PAT02- patent attorney from European law firm with UK offices)

> [T]here are going to bells and whistles that you add later. You can do that either in the same patent or in a different patent. You've got something that is a development of it that's incorporating other aspects which are separately patentable, probably best putting that on a separate patent. (Intellectual property expert interview 3#)

These quotes capture the "inside" manoeuvring and negotiation that goes into constructing an "outside" official account of scientific discovery presented in a patent document (Bowker 1992). In the first quote, the patent attorney explains how patent filings can accommodate, and even leverage, scientific uncertainty by allowing a particular piece of research to be translated into multiple claims, some more expansive than others. Because patent applications take time to review and examine, the applicants can conduct further scientific work to support – or refute – their more expansive suite of claims, before deciding which version to proceed with. In the interim, both filings will count as "prior art" for anyone else trying to file a claim on an overlapping area, even if the first set of claimants are still waiting to see if their wider set of claims can be supported. In the second quote, the interviewee explains how a set of research findings can be converted into multiple claims and even multiple patents by considering the "bells and whistles" of extra or additional claims about, for example, different areas of (potential) application.

Patents give the holders what Hilgartner (2018, 64) terms "configurational power": the "capacity to influence the specific arrangements of technical components, humans and organisations, and social roles and relationships that make up socio-technical systems". Legal scholars have similarly noted the suite of "private governance" functions conferred on patent holders:

> [P]atent holders can place conditions on use, such as clauses prohibiting use of the invention for particular contexts. They can also limit use by charging high costs for access to the technology, or as noted, they can refuse to license the invention thereby becoming the sole provider. Furthermore, how the patent is licensed can impact other technologies because some technologies require the use of existing patented technologies to operate. Thus, patent holder decisions have the potential to have significant knock-on effects for uses of other technologies, and for research and development within a field of technologies (McMahon 2021, 143).

These strategic ways in which patents are considered useful, or valuable in the context of competitive markets for innovations, including biomedical innovations has in turn a shaping effect on what is considered worth patenting and why.

Patents on "upstream" aspects of complex technology development that cannot be invented around are especially valuable because they create obligatory passage points for anyone wanting to work on a certain area of application. This is true for "foundational" patents such as those on iPSC (held by iPS Academia Japan a private entity spun out from University of Kyoto) and on CRISPR, but new "blocking patents" also emerge from subsequent R&D:

> So, the way you make dopamine cells is you have to use a particular thing called dual SMAD and that is currently patented only in the States by Sloan Kettering. But, that is a... no-one has got round that yet. So, there's going to be that plus the patent here on how you make dopamine cells. So, this, I think, is going to prove to be quite a thorny issue going forward, will be these critical IPs. (Academic stem cell scientist 2#)

This example concerns attempts to develop dopamine-producing neurons from iPSC as a possible therapy for Parkinson's disease. Anyone wanting to make this particular type of neurons from iPSC needs specific pieces of technology that is covered by patents in the US and UK, and which appear essential to the process.

For universities, the value of "critical IP" of this kind lies mainly in the potential of the patent to generate income, especially through exclusive licensing of the right to exploit the patented technology:

> [U]niversity tech transfer offices need to earn money to commercialise the technology and most of the large companies coming to them want exclusive licences. So, it's easier to do a deal where you give an exclusive licence. If they refuse to give an exclusive licence, then the licence fee will generally be much smaller. (Intellectual property expert interview 1#)

This valuation of patents based on anticipated future markets and revenue streams echoes the findings of Miller et al. (2009) in their study of Canadian TTOs, where they observed that TTO staff conduct their own valuations of scientific knowledge by anticipating the industries and applications that might be prepared to pay for licencing a piece of knowledge:

> For TTOs, the immediate user of early health innovations is a commercial partner. End users are imagined relative to this immediate user, with the nature, size and salience of the

> imagined needs of end users informing predictions about the likely interest of commercial partners. (2009, 1484)

Companies prefer exclusive licences, especially of "foundational" patents because this grants them a monopoly on an entire segment of a future market. For example, The Broad Institute has licenced its CRISPR patents exclusively to Editas medicine with the proviso that Editas can decide which targets it wishes to pursue and which to out-licence to other developers (Feeney et al. 2018). This means, for example, that Editas can retain exclusivity over applications it prefers, such as gene editing therapeutics for sickle cell disease or cancer, while also generating revenue from granting other firms a licence to develop CRISPR for other medical domains such as heart disease. In this way what matters to companies, becomes valuable to TTOs who make their decisions about which patents to support and which types of licencing to negotiate based on the value preferences and valuation practices of (biotechnology) firms. The revenue generating potential of the foundational patents on CRISPR/cas9, which in turn derives from the anticipated future markets for gene editing based therapies, is such that it has resulted in a protracted and expensive patent dispute between rival claimants at The Broad Institute and the University of California, Berkley (Panagopoulos and Sideri 2021; Feeney et al. 2018).

There are also other reasons why TTOs file patents: numbers of successful patent filings can increase their own reputation and status, and can also signal to other players in the innovation space that there may be gaps in their own knowledge represented by the claimed invention[7]. This illustrates the ways in which multiple different valuations (of anticipated revenue and future markets, of reputations and standing etc) are folded into TTOs' calculation of what science is worth patenting.

For companies, the picture is more complex. Start-up or small biotechnology firms are typically dependent on attracting investment from Venture Capital firms and other investors. One of the (multiple) metrics that investors use to assess firms as an investment opportunity is the size and extent of their patent holdings One UK academic who was involved in two stem-cell related university spin-out firms, explained: "you need to protect that IP so you can get interest from investors." (Academic stem cell scientist 6#). When patents become a metric, the internal content of each patent becomes less relevant. An intellectual property expert explained:

> [T]here is a bit of tension between patent filings and venture capital. Where venture capital people don't understand IP, they just look at numbers, so some [Senior company personnel] are very worried about giving up some of their portfolio, losing some patents. A lot of companies just want numbers for their venture capital people and they're no good to them. (PAT02)

When a number of filed or granted patents becomes a metric for assessing value (whether the value of a firm as an investment as here or a way of measuring the performance of a researcher or a TTO), the value of patent holdings is quantified and abstracted. In simple terms, the number of patents is more valuable than the content of those patents. This can explain how the current valuation practices in innovation systems incentivise and give value to patents that may never give rise to a practical product or service.

Equally, anticipating the need to get the licences in order to secure FTO in a complex technology field with proliferating numbers of patents can also inform a company's calculations about which patents are worth filing and how best to translate experimental data and artefacts into suites of patent claims. This situation is not unique to biotechnology. One IP expert explained the point of using an account of a former client that wanted to use a particular industrial catalyst, only to find there were fully 800 already-granted patents relating to its use. With no way to pay so many royalties or litigate against so many patents, only one further solution presented itself:

> Eventually, we got a licence, basically by developing technology that the various different patentees would, themselves, want to take a licence on. Otherwise, no access. (Intellectual property expert interview 1#)

They went on to explain:

> It's always important to advise the small companies, and large companies, don't just develop and patent the technology you want to use, develop and patent technology that your competitors may want to use so that you have a bargaining point." (*ibid.*)

This quote explains how companies can use the patents they hold to negotiate with other IP holders for mutual access, where both, or all, parties have rights over some steps or components needed to develop a complex product such as a cell or gene therapy. Thus, it can also be strategically valuable for a company to file patent claims on things they think their competitors' might want to access in future, even if these are not of core interest to the firm's own product(s).

These examples of TTOs and companies both illustrate Helgesson and Lee's claim that "examining the configuration of valuation practices is a useful tactic for examining the complex links between the scientific, technical, and market poles" (2017, 3). In that study, Helgesson and Lee demonstrated how "ideas about markets for pharmaceuticals can be folded onto ideas about how to design trials and how to select candidates to introduce in said markets" (2017, 2) showing how, in contrast to "linear" models of innovation, markets and market assumptions do not only appear at the "downstream" end of the R&D process but are folded in to earlier "upstream" valuations of what is worth doing in product development. Here we have seen a similar folding in of different anticipatory calculations of valuations about "upstream" markets and competitive advantage in innovation trajectories for biomodifying technologies. Assessments of the size of patent estate as a means to attract and impress investors, the licencing and revenue generating potential for key patents, the potential utility of patents as tools to leverage negotiation with competitors and secure market segments (also reassuring to investors and shareholders) and so on have all been shown to be folded into, and informing, judgements about what is worth patenting and about how patents should be constructed as sets of claims in the domains of gene editing, iPSC and bioprinting.

6. Conclusions

As previous work from the project team has demonstrated (Bicudo et al. 2022; Bicudo et al. 2021a; Bicudo et al. 2021b), the development of biomodifying technologies into biomedical products and services involves a progressive transfer of control of each technology and its trajectories from public sector institutions to private ones. This is not to imply that all biomodifying technologies arise directly from public sector research. Zinc Finger Nucleases for gene editing, for example, are owned, patented and out licenced by Sangamo Therapeutics a California-based biotechnology firm. However, CRISPR/cas9 and cellular reprograming to make iPSC did originate from academic work, and a lot of bioprinting techniques developed in a similar fashion. Moreover, as most biomodifying technologies are commercialised as tools and reagents sold (back) to public sector laboratories for the purposes of conducting further research, which then generates more patentable knowledge that in turn is often transferred to university spin-outs and small biotech start-ups there are repeating cycles of privatisation not merely a single event.

Publicly funded research may be conceived of as a "public good". However, contemporary governments often view the public good as being best (or even exclusively) served by economic growth through commercial innovation. Innovation policy, especially in High Income Countries, is often guided by the belief that private control of innovation will ultimately be guided to serve (this version of) the public interest by the "invisible hand" of market forces. Patents prove an important practical mechanism for effecting this transfer of control due to the "private governance" functions (McMahon 2021) they confer and the "configurational power" (Hilgartner 2009) this enables. This power is further amplified when powerful players consolidate extensive patent suites and claims on multiple aspects of a technology field.

The limits of this model, and the impact of patents on biomedical innovation, are well documented. Both the proliferation of patents and the extensive private governance functions conveyed by intellectual property rights have been associated with high prices and uneven and unequal access to medicines within countries and between High Income Countries and Low and Middle Income Countries. These problems are not novel, but were made starkly visible during the Covid-19 pandemic (McMahon 2021; Walsh et al. 2021) and have led to calls to change global systems of biomedical innovation to ensure greater public benefit (Swaminathan et al. 2022; Torreele et al. 2021). Biomodifying technologies are not vaccines, but there are important similarities. Like vaccines, cell and gene based therapeutics, which includes those based on biomodifying technologies, are very hard to reverse engineer or mimic without detailed knowledge of specific manufacturing processes (McMahon 2021). The small number of cell and gene therapies that have reached the market have very high market prices and have raised concerns about health systems can pay for them (Jørgensen and Kefalas 2017; Devlin 2022). What the above analysis adds is to show that these outcomes are neither inevitable nor purely the result of individual choices or some notion of "the market" as an ineffable force acting on the world at large.

Instead, as with our previous study of translational scientists, durable institutional practices of valuation act to shape and incentivise behaviours in relation to patents and patenting even before any formal period of assessment is encountered. This illustrates performative nature of valuation:

> The act of measuring, ranking or rating not only affects how the value of something is established *but also affects what is considered valuable – or what "counts"*. (Hauge 2016, 126, *emphasis added*)

The formalised criteria of patent examination and the particular mode of valuation through which examiners enact their assessments create the possibility of fragmentation of complex inventions into multiple different patents held by different parties. The stable, embedded nature of these valuations means their operation can be anticipated and responded to in a strategic manner. In the context of a competitive, commercial global market for innovation, anticipatory valuations of this "downstream" market become folded into assessments of what is worth patenting and how patent claims should be drafted, augmented (the "bells and whistles") and multiplied to secure future advantage. This creates a chain of value, where what matters to investors and shareholders influences what matters to companies, which in turn informs the decisions of university TTOs, all of which must be considered by patent attorneys and their clients. It is important to stress here that this is neither a deterministic nor a linear relationship. At every stage multiple valuations must be considered – scientists and TTO staff must consider how any decision about patenting in light of the various different ways their own performance is metricised and evaluated by employers, by peers, and indeed in terms of their own career and personal priorities. Companies must consider the cost of filing and maintaining patents and which of the hundreds of national patent offices to file with, against the potential strategic value of each patent, how their patent portfolio will look to investors, what rival companies are doing, potential future revenue streams from licensing versus excluding competitors from key market segments and so on. Nonetheless, the general pattern of bringing market considerations into supposedly "pre-market" phases of R&D is evident.

This analysis shows that rather than constituting a malfunction of the system, the outcomes here are fostered by the valuation practices embedded in the patent system as they encounter the nature of life sciences innovation. Valuation is an analytic approach, not a legal remedy to IP problems, but it does provide a new way of understanding and mapping the way innovation is steered. In light of proposals to reconfigure global biomedical innovation to give greater weight to the public good (Swaminathan et al. 2022), I argue that in order to change what is valued, it is necessary to change how value is understood, measured and calculated. Changing investor proprieties may be difficult to achieve without significant regulatory reform, but universities have a clearer mandate to serve the public good, and for example TTOs could be encouraged to rethink the priority of patenting in their mission. Some technologies may be worth patenting (for example CRISPR "gene drive" technology was patented by academics as a way to try and ensure more responsible oversight of its use [Scheinerman and Sherkow 2021]) but others might deliver greater public benefit if they were more open and accessible. Both open source software and open hardware movements provide evidence of alternative innovation models that rely less on private governance and monopoly rights. The international open-source movement in bioprinting, which aims to develop and share projects for affordable bioprinters to be used in various laboratories, including those lacking resources to buy the most sophisticated scientific equipment demonstrates that this is possible. This movement has been underpinned by the initiative of individual academic researchers, but there is noth-

ing to suggest that it cannot gain, at some point, some form of institutional recognition and support. Alternatively, if bioprinting products and services get closer to clinical application, incumbent commercial interests could use patents and configurational power to squeeze out open source developers and create a centralised market dominated by a few big firms.

Understanding patents as (part of) the ecosystem that shapes emerging technologies also illuminates the wider web of folded, nested valuations that feeds into the whole system, from institutional incentives for university TTOs to the norms and duties of a patent attorney to their client. Any potential remedies for the deleterious effects of the patent system must look beyond the formal description of patents to consider their impact on this wider domain.

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Data Availability

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I declare that I have no competing interests, whether financial, personal, or otherwise relevant to the content or choice of journal for this manuscript.

Notes

[1] CRISPR stands for "Clustered Regularly Interspaced Short Palindromic Repeats" in reference to the characteristic sequence of the RNA "targeting domain".

[2] For a publication dealing with RQ2 in detail see Mourby et al 2022.

[3] The EPO is not a national office *per se* but acts as a central examining body capable of awarding a "bundle" of patent rights valid in all countries that have signed up to the European Patent Convention (EPC).

[4] Specific prohibitions include examples include, cloning human beings, modifying the germ line genetic identity of human beings, commercial uses of human embryos, or modifying the genetic identity of animals and causing them suffering without substantial benefit to man or animals.

[5] For a discussion of why CRISPR has proven so widely adopted compared to other gene editing tools see Martin et al. 2020.

[6] For a review and critique of a broader range of philosophical justifications of patent right see Papaioannou 2006.

[7] My thanks to an anonymous reviewer for bringing this point to my attention.

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"I Don't Know if It Wanted Me to Dance". On Leading and Being Led in Human-eGate Interaction

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Abstract
Automated border controls, such as eGates, have become an everyday experience when travelling. Other than their divisive nature as a biometrical border, these access control systems are generally either taken for granted when functioning smoothly, or are seen as forcing humans into a scripted sequence of actions. Based on a technographic study of laboratory eGate-testing in Germany, we argue for a different approach in understanding this specific human-machine interaction. Drawing on Pickering's (2012) "dance of agency", we will show that the reciprocal interaction of using an eGate comprises facets of routine, anticipation, and mimicry. By becoming more attuned to the oscillation of agency, where leading and being led is reciprocal, we must recognize that even automated systems rely on human beings, their bodies and their senses to make adjustments. Our analysis suggests that both entities are interwoven in an asymmetric way, providing a new perspective on border technologies that incorporates usability and STS-perspectives. In doing so, our (laboratory) testing demonstrates that it is possible to return and retain human agency within interactions with border technologies.

Keywords
eGates; automation; usability; human-machine interaction; dance of agency.

1. Introduction

> I don't know if it wanted me to dance. But [laughs] [...] It already said very clearly, "okay you're not where you're supposed to be right now, so please move [...] again more precisely"[1]. (User 9)

Contemporary border control systems are in a constant process of reinvention, and automation, as with the case of eGates, is central to this. Even as the latest models of eGates are installed, newer versions are being evaluated in the laboratory. This focus on a search for solutions, rather than gaining knowledge, can be understood as a type of "tinkering" in the laboratory, as Karin Knorr (1979) coined it.

Generally speaking, eGates are seen as a solution that allows for the fast channelling of ever-increasing numbers of people in the border context. They should accelerate a process that was formerly undertaken by human border guards: optimising a prevailing filtering function, and separating trusted from less-trusted travellers (see Adey 2008). Whether they actually speed up bordering processing has been challenged by scholars, highlighting that automation and the development of a "self-service border" has met with a degree of resistance (Sontowski 2018, 2741; see also Leese and Pollozek 2023).

Our article follows the logic of looking at the micropractice of border technologies and sheds light on the specific human-machine interaction within the testing of eGates. Based on a technographic[2] study in an eGate laboratory, the article focuses on the human testers' experience of the system, an example of which can be seen in the introductory quote. With its metaphorical reference to dance, it exemplifies some of the key ambiguities in the human-machine relationship on a semantic level, an issue that can be understood as a reflection of an (in-)adequate reading of a technically designed interface. On an ontological level, however, it refers to what Andrew Pickering (2012) called the "dance of agency".

When focusing on the micro-practice of automated access control systems, eGates are either mistakenly taken for granted as "smoothly functioning", as Simon Sontowski (2018, 2731) emphasises, or seen as forcing humans into a scripted sequence of actions, as Dominique Linhardt (2000) extrapolated in his study of access controls at airports. This is congruent with the classic view of Michalis Lianos and Mary Douglas (2000), who characterised automated processes as impossible to "negotiate" with (Lianos and Douglas 2000, 264), something which has a clear impact on human-machine interaction. Since 2000, automation, digitization, and different generations of biometrics have permanently changed the field of border control, a topic which has been scrutinised by a broad field of scholars within the nexus of STS, migration and border studies, and critical security and surveillance studies. Border technologies have therefore previously been looked upon either for what (kind of border policy) they represent, or for how successfully the technologies achieve these objectives.

Technologies can therefore be seen, just like the border per se, as reflecting what Paul Trauttmansdorff defines as an "epistemic prism for analysing power transformations and dynamics" (2022, 135). As such, they are manifestations of a border regime, a subject which has been highlighted with varying emphasis. Previous works have dealt with matters such as analysing the increasing role of data (Amoore 2006; Glouftsios and Leese 2023; Leese and Pollozek 2023), changing biometrical systems (Sutrop and Laas-Mikko 2012), how border technologies (and their infrastructure) render the body knowable (van der Ploeg 2003; Casartelli 2021), the rationales of the border's (social) filtering function (Lyon 2009; Adey 2008), and the securitising of mobility (Salter 2013). As for eGates, Louise Amoore (2013, 163) characterises automated (algorithmic) security decisions as "no longer a decision as such, but only the application of a body of knowledge". With this emphasis on the mere application of knowledge followed by Amoore's (2021) analysis of the machine learning procedures that entail the "deep border", the focus turns to new forms of technological inscriptions that prevail in the field.

The envisioned practical task of the eGate system is to verify that the presented form of identification matches the person currently holding the document. In doing so, the eGate

filters travellers into verified persons, who are allowed through the access control, and those whose identities are unverified, and are thus denied access. Even though the practical use of eGates has previously been studied (see Sontowski 2018; Noori 2022), the question of agency within this specific human-machine interaction has been largely overlooked.

Our study approaches eGates solely as a technological artefact, thus leaving the representations of the so-called "smart border"[3] and the analysis of "sovereign bordering" within the laboratory (Bourne et al. 2015) aside. Instead, we focus on the – to our knowledge – neglected process of how people actually interact with eGates, asking if there might be a way to look at the human-machine interaction at play, besides that of a non-negotiable force of technology on the human user. We argue that what Lianos and Douglas (2000) frame as non-negotiation can today be characterised as an oscillation of agency in light of new interactive constellations. To do so, we begin by elaborating on the usability of eGates within the laboratory, as this is the predominant methodology in this field. After introducing an analytical lens of seeing the interaction as a "dance of agency", we will highlight the three key aspects of our empirical study. Firstly, we will show that comprehension of the intuitive use of an eGate cannot be understood as a characteristic of the technical object, but can instead be viewed as a routine that users achieve by tuning their behaviour to the system. As this tuning encompasses waiting, we will secondly show that much of the waiting within the eGate interaction can be understood as a form of what Sloterdijk calls "passivity competence" (2009, 591). Finally, we will illustrate that the reciprocal process of passing an eGate can be understood as highly mimeomorphic. This leads us to a new reading of eGate-human interaction, which might point to a call for a more systematic engagement in the research of in situ interactions. We therefore suggest that human agency is key to moments of engagement with, influence in, and creation of technology that, at first glance, leaves no room for negotiation.

2. Methodological framework

A key feature of the technical demands eGates place on their users is a standardised procedure that is predefined by the device's composite components, including several physical barriers, a document reader, biometrics capture devices and user interfaces (like monitors or LED signals). Their specific design is based on developers' assumptions about future users, particularly their sensory, acting and cognitive capabilities and limitations (Lang 2002, 3). In order to enable smooth communication, interfaces should therefore not only allow uncomplicated handling, but also intuitive use, an important attribute of interactive systems. Although research draws on (potential) users' expectations and desires, studies on the usability of eGates mostly attribute problems to the users themselves, primarily by showing that they are "struggling with the system" (Ylikauppila et al. 2014, 170). They refer to knowledge deficits, which are mainly attributed to a lack of familiarity with the system. In contrast, the eGate is expected to work at a "precise method of operation" (*ibid.*) that guides users. Usability research on eGates has thus far largely asked whether users are able to follow the systems' directions, overlooking what actually happens at the interactional level.

An STS perspective is therefore able to fruitfully step in where prior research on usability

stops. By drawing on Madeleine Akrich (1997, 207), the reconstruction of the inscription and de-scription of artefacts allows "new forms and orders of causality" to be described. EGates are inscribed with a vision (the "inside" of technology) of working easily, efficiently and in an intuitive manner. This vision leads to a specific script ("the outside" of technology), that is supposed to organise users' behaviour. Although the script is "a major element for interpreting interaction between the object and its users" (Akrich 1997, 216), it remains open to adjustments as to how this inscribed notion is "de-scripted" (*ibid.*, 209) by the actual user. On a methodological level this involves following both the user and designer/developer, with two specific objectives: to shed a light on the black box of the scientific process; and to point to the way in which users "matter", as emphasised by Nelly Oudshoorn and Trevor Pinch (2003). To make sense of this interaction, we must address two levels of thought: the first is the attempt to conceptualise the literal communication between the user and the system, together with its design background; the second, meanwhile, lies at the level of an abstraction of how this interaction can be grasped from an STS or philosophy of technology standpoint. We aim to integrate both these schools of thoughts. While we will consider human reflection on the interaction with the automated system, we will still analyse both entities in this "adjustment" process (Akrich 1997, 207) as a performative interaction. Here Pickering's (2017, 382) concept of the dance of agency is helpful as it focuses on performance as a capacity of "both human and nonhuman". His characterisation of the dance as "an open-ended, productive, and transformative back-and-forth" (*ibid.*) allows us to conceptualise our observations of the interaction between users and the eGate as a dialectic of accommodation and resistance on the level of in situ interaction.

Contemporary automated verification and access controls can be understood as post-interface (Andreas et al. 2018), consisting of material installations with computational interfaces. At these physically localised intersections of input and output, humans and machines encounter each other in a process of transferring and decoding not only signals, but also physical influences and material components. In this human-machine interaction, the agency of the human and the machine diffuses (*ibid.*, 18). Interactions then merge into interconnected forms of cooperation and collaboration (Rieger 2019, 159), creating situative meaning. Thus, to understand and to disentangle the forms of agency at play, ascriptions and expectations toward actions must be thought of anew (Andreas et al. 2018, 18). Pickering's emphasis on both entities therefore reformulates the discussion on the impact of the configuration of users and technology, as it focuses on the adjustments made by their interplay to interactively stabilise each other. As he notes, instability is an ontological condition that is less cognitive. Indeed, performative processes can instead lead to "islands of stability" (Pickering 2011, 5), where certain aspects of the world are taken for granted. In the context of border and identity control, "technosocial assemblages" (Pickering 2017, 390) like eGates can be seen as contested islands of stability, a normalised technical procedure at the airport, in which relations to its user are formulated as usability. Thus, simply knowing how to achieve usability does not guarantee that this goal will be reached. Focusing on the users and the way in which they interact with the technology means looking at both the influence that the technology has on the user, as well as how their way of using it can modify the artefacts themselves. Hence, we have to ask how users perceive the way the machine communicates with them.

The empirical material that this article is based upon is part of a larger study on the technological developments of "truth verifications" within airport security. The following insights are based on one of our case studies that concentrated on the development of eGates, including their testing, for which we conducted technographic observations and interviews in a laboratory. Technographic observations are a specific form of an ethnography of technology, which focus "on situations [...] and sociotechnical constellations" (Rammert and Schubert 2006, 14). One of its key rules is therefore to describe interactions in a "meticulous" way, in order to reconstruct the "actions and reactions, iterations and disruptions" for subsequent analysis (Rammert 2008, 350). In doing so, the investigation was conducted using the methodological strategy of *following the disruptions* (for further elaboration see Paßmann and Schubert 2022, 293-296; Rammert 2008, 348-350), assuming that functioning technology "withdraws" in use (Heidegger 1967[1927], 69) and that the cultural and socio-genetic agency of technology becomes visible in its disruptions.

Thus, we investigated the interaction of technology (here, the eGates) and humans (in this case, the participants of the test runs) in their mutual dependency within the verification process. The term *participants* described everyone who took a turn in going through the eGates in the course of a test run. We further differentiated between two specific groups of participants: those we referred to as *users*, and those we referred to as *researchers*. *Users* characterised those who were solely engaged for test runs. *Researchers*, on the other hand, were people who worked within the context of the laboratory, but still took part in the test runs. The users were not given any specific tasks or information before their first test, other than to go through the eGates. While the test runs aimed to monitor the functioning of the systems, our focus was directed at the users and their human-machine interaction. For the purpose of the analytical focus on the disruptions and descriptions in the interaction, we neglected the inscription site of the developers. We will, however, highlight the human interventions from the operator side of the system as and when it becomes relevant to our study.

We chose a technographic approach for the observations and interviews. In terms of methodology, this meant observing technology in its making, here in its use, thereby seeing technology as an actant in its own right. This form of focussed ethnography was conducted within the context of four short ethnographic phases on site in 2022. It included 57 participant observations of test runs, 32 situational (instant reflecting) interviews with participants, and an additional nine comprehensive qualitative interviews with researchers and developers. Regarding the specific distribution of agency, the following key questions guided our analysis, which we conducted as an abductive process (Tavory and Timmermans, 2014): how did the technical script determine the human action? Are users conforming to the intended processes? When and how did users direct and shape the interaction?

3. Intuitive interaction?

The use of eGates follows a defined mechanical sequence. It begins with the user being asked in writing and illustrations via icons on a display to place the passport on a reader. In the laboratory setting, the participants were equipped with a card (containing a RFID chip), that

simulates the passport. After the information stored in the RFID chip has been read, a glass door opens, and the user is expected to enter the corridor. A monitor at the end of the corridor displays the user's facial image, taken by a camera. Here the machine reading or digitization of the body (see van der Ploeg 2003, 64) begins. Different coloured silhouettes and/or instructions for the correct positioning of the body in front of the camera are shown on this display. Once the facial image has been captured and compared with the biometric features of the photo and found to be identical, another glass door opens and releases the user from the eGate.

Interaction designs aim at the highest possible degree of usability, something that in turn has become synonymous with the term "intuitive use" (Oswald 2010, 2). Intuition, as Dawid Kasprowicz (2018, 160) puts it, refers to immediacy and includes the notion of smooth and unambiguous communication.

While reflections from some of the users confirmed such an intuitive interaction with the eGate, we argue that despite their characterisation of the passage through the gate as "very intuitive" (User 25), the presupposition of this intuitive character cannot be supported. This becomes clear when considering users' descriptions of their first time using the eGate in which they reported being surprised:

> Suddenly you put on a passport, then the door just opens, well, then you don't know at first what's happening and then yes, suddenly the picture appears. (Researcher 3)[4]

Here, the "informatisation of the body" (van der Ploeg 2003, 58) affects the embodiment as such. The moment in which the sensor technology co-constitutes their body appears to be the most irritating, because it leaves them unsure about what they are supposed to do. This shows that the technology does not speak for itself. Certainly, interactions with the human operators helped users reduce initial uncertainties, but the knowledge acquired here refers to a strictly instrumental handling: getting instructions about how to insert the card correctly into the card reader, or that they have to stand still in front of the camera. This additional help from the operators occurred when the users kept experiencing difficulties. Our observations show that users still lacked confidence in how to behave despite the instructions, frequently asking themselves when confronted with the camera display:

> What happens now? Do I have to look straight ahead? Do I have to look down? Or what do I have to do? (Researcher 3)

David Oswald (2010) argues that design processes are developed merely to structure possibilities for action, which are reflected in the design of a particular form or interface. This can be seen in the materiality of the reader, which clearly signals that users must place their card on the reading field. The visual communication via the card-reading display is also clearly understandable, although the users were often uncertain about *how* the card should be placed: Which side should be up[5], and "does it have to be straight in there or at an angle?" (User 2). Then the further sequences of action after this first insertion of the card were often described as unclear, and the handling of the non-(direct-)functioning of the reading process manifested differently. One way of handling these uncertainties is by switching the card or correcting

the position, and it is these actions that add up to experiences of routine handling that retrospectively lead to the perception of an intuitive handling, as one user explained:

> Yes, it's been one thing at the beginning, that I had to learn a bit. That I slide it [the card] in correctly. That I don't just put it down, but that I have to check on the screen: okay, is it placed in a way that the system can read it or not? But in the meantime, this has been integrated into the automated memory, so that I automatically place it correctly. (User 25)

The user recounts his first experience as one of trial and error to find out the right way to handle the card reader. This not only contradicts the notion of an intuitive handling but also illustrates that only through the dances of agency does such a notion unfold. Until the user achieves this island of stability, where communication becomes slowly comprehensible and coherent, a routine cannot unfold in the interaction with the technology. The passage illustrates a specific element in the dance: users structure their interrelated behaviour based on an anticipation of expectation (Lindemann 2015, 73). Thus, in the eGate setting, communication is about the systems' request for action, because it only permits further activity after the user has performed an adequate action:

> I don't know, I just lay it [the card] on it. Then it tells me to keep still and [...] then I go towards the gate. (User 8)

Many of the testers understood the interaction with the eGates in this sense, of a request for action, with the system assuming human qualities. They talk about the system "speaking" to them, about something being requested of them, or about the system refraining from making any request. Their interaction thus requires an act of understanding and as they themselves feel that they are in the reactive position, requirements for action have to be read, interpreted and, most importantly, added to lived experience. These requirements are not always immediately accessible. After inserting the card correctly and then standing in front of the display, where a silhouette appears, the users get the impression that the system wants them to move. But with its hints, the display does not initially provide intuitively obvious information for the required procedure, leading the user to move back and forth in front of the camera. This user's trial and error-acting is perceived as if the system wants them "to dance" – which would be a preposterous affordance even in the context of a laboratory situation.

As this shows, it is only a repetition of dances that makes the initially irritating request to find the correct place to put one's body more understandable. As the user explained, when the request becomes separated into literal individual steps, he is then able to follow:

> It already said very clearly, "okay you're not where you're supposed to be right now, so please move" [...] "again more precisely". (User 9)

Here the routine itself unfolded in ways whereby the users have to provide their own meaning. However, the translation and understanding of expectations do not always succeed, as the perception of these faults show. These are not errors per se, but can be aspects that delay

the process because it is unclear what the system wants. This may be due to the ambiguities already mentioned, the lack of clarity about how to act, and the visual prompts on the display (silhouettes or instructions) not being perceived as helpful. Users reported feeling forced to modulate their distance and body height themselves in relation to the norm inscribed by the machine, as one user explained in detail:

> Well, I don't get as close as I probably should in order to completely fill that empty head. But I don't think I need to either. So, I don't know if the standard head is just designed for a 6'1" man [...] I don't know – so my head is significantly smaller. And that doesn't matter though. So, that's a space and that's okay. (User 20)

The user acts in a way that deviates from the intended course of action, ignoring the "pre-scription" (Akrich 1997, 208) of the system to fully fill-in the silhouette. There is a lack of cooperation and the inscribed agency of the system for modulating the users' action is suspended. By taking the perspective of designers, this must result in a breakdown of the system: filling the silhouette is expected to indicate the correct position and distance from the camera that is needed to achieve a picture of sufficient size and resolution to enable a match with the biometric picture in the card. Instead, the user exercised her own agency by moving her body only as close to the display as experience had taught her would result in a sufficient camera shot of her face. Thus, a clear "self-evident" distinction of the body itself and the information about it cannot be drawn (see also van der Ploeg 2003, 58). As this is also an example of a mismatch between "the inside and the outside of objects" (Akrich 1997, 207), we will further elaborate on the issue of adjustments.

4. Waiting

Pickering's (2017, 382) suggestion of the need "to take seriously the performative grounds for a dualist perspective" of the human-machine entities has the consequence of "put[ting] us humans in our place". Within the eGate interaction, this place often means that the human user is waiting for the machine to proceed and to communicate what further actions are required in order to proceed. The users in our field observation had to wait for the machine to read their entrance card, then to wait for the door to open to let them into the corridor, then wait for the camera to frame their face, then for the software to recognize their face (while comparing it to their ID card picture), then wait again for the door to let them out of the corridor. The periods of waiting therefore dominated the whole user experience within the eGate. To grasp the essence of this, we can follow Gerd Sebald (2020, 994) when he defines waiting as "only oriented toward an event's occurrence, not its substance and thus must be differentiated from a-waiting an event (anticipation)". Furthermore, he states that waiting "is the temporal difference between the (first) anticipation of an event and its occurrence" (*ibid.*). Understanding the action of waiting as a pure projection onto the future helps us to interpret the quality of waiting that we observed. Many of our users experienced this waiting as an annoyance, a feeling which came from the anticipated occurrence having not yet set in:

> That is a bit irritating. So, it is not quite clear why you have to wait so long. I've accepted that you have to wait a little longer because I've been through it a few times. (User 18)

The users at each stage expected a certain action of the machine: to identify, to read with a follow up action that allows them to proceed; clearing, giving approval, opening the door. Instead, they found themselves repeatedly in a situation where they did not see any action by the machine. It was not just unclear to them *what* was happening – since they were aware of the black boxing of the machine – but rather *if* something was happening at all. For the dance to evolve, both entities alternate in activity and here the "passages of human passivity are precisely passages of material activity" (Pickering 2012, 4-5). But this does not mean that this activity becomes part of an island of stability regarding how to effectively pass the eGate. Instead, the machine becomes unreliable, as its agency is not communicated to the users. So when the human actors do not see that there is an action on the part of the machine, this forces them into a seemingly passive role. Additionally, when they started to act, because they felt that the machine was not acting as it should, they became insecure, not knowing if what they were doing was correct. In the laboratory experiments, the users reflected that it would have been helpful to know why they were waiting, because, as Sebald describes it:

> We indeed do ascribe delays to a certain extent to problems of transmission, which is also confirmed by the machines, be it by an hourglass icon, a progress bar ("Loading, please wait"), or any other symbol signifying delay. (Sebald 2020, 100)

Thus, if they knew why they were waiting – whether due to malfunction of the machine, their own wrong actions, just slow processing – their agency could have been played out: they could have adjusted their actions. It was the lack of communication on the part of the interface (and here again, a lack of reduction of the complexity) that kept the dance going.

This points to another quality of "waiting". Mikio Fujita (2002, 108) has differentiated two qualities of waiting: what is waited for and how we wait. The first should not be confused with precisely what is anticipated, but rather the broader shift which one waits for. Fujita gives the examples of nature (waiting for a change in season), becoming (birth of a child) and instrument machinery (which is our realm). Each anticipated process is different in the manner of its impact on ourselves and therefore has a different effect on the way we wait. In our case study, there was nothing at stake for our users, since this was part of a research process in the laboratory. Although Fujita (2002, 110) describes the realm of instrument machinery as a "world of means and ends" in which it does not matter how we wait, since this does not pose a difference for the machine, it would be different for the eGate users who are waiting to pass a real border. In the real context a perspective is helpful, which points to the ordering effect of temporality in datafied environments (Leese and Pollozek 2023, 2), since temporality cannot be seen independently from the devices through which it is experienced. On that note, one can imagine that the kind of nervousness, uncertainty and anticipation that was already being observed in the laboratory would be increased under real conditions, as reflected by the users:

> I think if you actually give your passport and it loads for so long, that's a blatant stress situa-

> tion. So [...] for social reasons, so to speak, I would rather say it would be pleasant, if it then simply said, "we are just processing" or "everything is fine". (User 20)

The way one waits can involve being patient, with hope or expectations, as Fujita says, but also with fierce anticipation when it comes to our research example. In the laboratory, patience was the key characteristic that we observed while users were waiting. The users thought about things, moved a little when they thought they had to adjust themselves, bounced, fiddled with their glasses, all of which again can be interpreted as endeavours to pursue the dance.

The specific process of waiting that we observed can be grasped in relation to what Sebald (2020, 998) characterizes as "waiting for the readiness to communicate, waiting for the diverging selections of information, utterance and understanding". Another step in his description is termed as "waiting for the follow-up communication". This includes a specific timeline or, as Sebald phrases it, this form of "communication is sequentialised and gains its own particular rhythm" (*ibid.*). When this sequence is out of balance, it leads to irritation:

> Then I first thought he wouldn't recognize me. Because it took a relatively long time and you get a bit irritated somehow when it doesn't work out the way it did before. (User 15)

The specific timely rhythm is just one characteristic of this interactive dance. An even more fundamental aspect is that this human-machine-communication is no longer based on verbal interaction, but rather on textual and symbolic signs on screens (see Sebald 2020, 991). In our (general field) example, border control has previously been offered as human-to-human, verbal and visual communication at the border police counter, but which is now complemented by the choice of using a purely electronic text and visual language based eGate. One of our users specifically makes the comparison:

> If you stand in front of it too long [...], then you start to ask yourself, will I get through or not? Yes, it's like when the official takes too long to put the ID card in the machine and doesn't make a friendly face. And the moment he makes a friendly face, you have no more concerns, but when he looks grim, you think "Oaahhh what happens now". (User 22)

If the technology proves to be irritating in the manner of its communication, the testers adopt their own strategies to deal with it. Waiting for the technology to react, for example until the door opens after the card has been inserted into the reader, can be seen as something more active than meets the eye. By drawing on the work of Peter Sloterdijk (2009, 589), whose thoughts are framed by the exploration of "competing modi anthropo-technical behaviour", one of these modi is the willing exposure to the efficiency of others. As in the case of our eGate interaction, or rather the dance – where one entity swings back, letting the other turn itself around – the user actively allows something to be done with themself. Drawing on Sartre, Sloterdijk (2009, 591) emphasises that this form of welcomed passivity is an act of "appropriation" of an "external determination to reappropriate" oneself. This becomes evident when a user stands in the eGate, attempts to be in the camera frame and waits for the system to signal that everything is fine, and they pass. Sloterdijk coins this as a "postponed

way of self activity" (*ibid.*, 590) since the user exposes themself to the activity of the machine. In allowing others to affect oneself – such as the software underlying the interface, that will signal that the user can pass and direct the machine to open the gate –, the user participates in an external competence (*ibid.*, 593-594). This occurrence after the period of waiting for the follow-up communication (Sebald 2020) has been phrased as a call to action, either as the machine is "telling me to" and only a few times as "it was asking me to [do something]" (User 27). Here, we witness the "skilful nonproficiency" (Sloterdijk 2010, 14), which finds its shape not just in waiting, but in the specific form of how we wait for the machine to take the next step to keep the dance going. For this a contemporary idiom is serenity (Sloterdijk 2009, 594). So, patience can be transformed into serenity, as when our interviewees said that they would give the technology the time it needed, or if they excused it by saying "that can just happen" (User 19). Reflections like that were ascriptions of a human-like neediness of the machine to which our users reacted with serenity.

5. Reciprocal adjustments

We have looked at the active passivity of waiting as a reaction and the perceived passivity of the machine as the missing reaction. Now we will look at a third facet of the interaction at play: the "zones of intersection where the non-human world enters constitutively into the becoming of the human world and vice versa" (Pickering 2012, 4).

The oscillation of activities are also oscillations of agency. In human-eGate interaction this can be quite interwoven and fluent, as the phenomenon of waiting can best be described as reciprocal anticipation, resulting in adaptations which we can call reciprocal mimicry. At first the human user anticipates what the machine might expect of them. This evolves partly through the interpretation of what the eGate communicates visually, with text, but also through its plain materiality and design. The actual performance of the machine leads to what the human user anticipates by their own behaviour. Central to this specific performance of the eGate interaction is the materiality of both entities. While much of today's digitised communication is characterised by the loss of relevance of physical presence, the opposite is true for our case study. In the human-to-human border control context, both actors are present, verbally and visually engaged, and are supported by certain technological devices (e.g., passport scanner). In the case of the eGate, the bodily co-presence of the human in the interaction invites a totally different activity. We can observe the request for routine and passive activity as a "recentering of the human being" (Andreas et al. 2018, 10), even though they only make up one part of the interaction. This recentering can be described as a new quality of interaction, since digitised media would not request an active user that is engaged in an interface, but rather one whose passivity is necessary for the interaction. The human user needs to show a "conscious withdrawal of the activity on the part of the user" (see *ibid.*, 12). Our users even draw the conclusion that their (passive) actions are imbued by a somatically felt routine: "Intuition somehow comes from knowledge. So the body will have gotten used to it somewhere" (User 5).

This leads to another point of relevance the human body has in the interaction, which is that of a medium to make oneself understandable to the machine (Rammert and Schubert 2019,

127-132). This kind of interaction can be seen as reciprocal mimicry, which Harry Collins (2010, 55) describes as "mimeomorphic", when there is no varying social context. In contrast to his understanding of polimorphic actions, which can only be conducted by humans, he sees mimeomorphic actions as mechanised, repeating actions from machines and people (like a salute). This reciprocal anticipation can meet with mixed success, sometimes functioning better and sometimes worse. The eGate users in our laboratory felt prompted, but sometimes did not know how they should comply with it. They even complained that the technology did not "play along". An example of this was when they needed to extensively adjust their posture and position, despite the fact that the corresponding actions, such as adjusting the camera in height or horizontally, should have been carried out by the technology itself. Some users were literally performing "dancing steps" in front of the camera: changing their distance to the monitor by repeatedly going forwards and backwards, or by stretching and getting on their knees. As with "waiting" these adaptations can be read as "skillful nonproficiency" (Sloterdijk 2010, 13), as users' actions sometimes do not have a causal effect. In the "dance of agency" this is a taking on of action by the users while the machine remains in presumed passivity, as the technical processing remains invisible to the eyes. It then shows that the machine is programmed to anticipate the human behaviour and reacts to it in a mimeomorphic way.

The central aspect of the facial recognition component in an eGate was the location of the person to be captured by the camera and so render the body into information. The head frame shown on the display attracted a great deal of attention. It has been recognised as a prompt in which one should fit one's own head, and correct one's own position until it matches correctly. This is where the intuitive interaction comes into play most readily, since the framing provided them with sufficient orientation. The users gave a variety of descriptions of how the instruction to bring the head to a specific height is conveyed by signs, like a head contour. Although it is mostly clear how the head must be positioned, the challenge remains to implement this, and thus the in- and outside of the machinery are experienced as incongruent. In this context, users reflected that it was not clear to them how their head should be fitted into the displayed border, for example because the size of the face and the size of the frame could not be reconciled. Others lacked an orientation point, indeed, it was unclear to them where exactly they should direct their gaze.

> Interviewer: "How did you know where to stand?"
> User: "I don't know, that just has been the problem. I was standing at the gate; I think I was standing a little too far away. The device didn't react and at some point, I noticed that the frame around my head had a little more distance than I thought was normal. So I took another step forward so that my face was practically completely in the frame, so that there was no air between the frame and my face". (User 28)

At this point we witness the oscillation between being led and leading the interaction. Sometimes the users would adapt the location of their body in anticipation of the action of the technology. They would do so by configuring height and distances to the camera through steps forward or back or by leaning their upper body back and forth, or even adjusting their height by crouching or stretching. Here, Sloterdijk's description of humans as "adaptive bi-

omachines" (2010, 11) seems to characterise such users in their eGate interaction. The machine adapts to the user and the user to the machine. In the eGate, these adaptations come in the form of mimeomorphic actions, since they are mechanizable on the part of both. Thus, the continuing change of agency becomes apparent.

6. Final remarks: Oscillations of agency

Our research showed that technology does have an inscribed logic of action that functions like a script (Akrich 1997), but that the script does not always reveal itself at the first time of use. The technology therefore requires human adaptation for it to function as desired. The users must adapt by learning to read and comply with calls to action. We do see the relevance of Linhardt's (2000, 84) description that machines force humans "into a very specific format of action". We are, however, missing the recognition of a reciprocal influence in this characterisation of human-machine-interaction. Furthermore, the consequence that humans cannot negotiate the required act in a literal sense no longer applies to current human-machine interactions. By adopting an STS perspective on the co-constitution of actions of human bodies and material technologies, the interaction can still be understood differently from being predetermined and instead be seen as a "technically conveyed and sensually embodied" interaction (Rammert and Schubert 2019, 125).

Our case study showed that the scripts of interaction are not inscribed by designers alone, nor followed upon as planned. They are always co-authored and modified, and one could even say that they are also negotiated by others such as the users. Therefore, we saw that the concept of intuition works on "fragile chains of operations [...], [which] are composed of simulated movements, body routines and industrial norms" (Kasprowicz 2018, 161). In Pickering's work on the islands of stability, which he sees as a manifestation of the "dance of agency", he shapes the idea that both entities are interwoven in an asymmetric way (Pickering 2017, 394). Our results support this insight: by scrutinising the concept of usability and taking a closer look at the agency of humans and technologies in interaction, we have seen both the tuning of technology into the social and the tuning of the social into technology. In the dances, technology's agency is not something stable.

Determining the process of walking through the eGate and the feeling of intuitively handling the walk-through is better termed as an idiosyncratic routine stemming from reciprocal mimicry. That indicates the importance of materiality, both in a physical way and by acknowledging the "body of information" that unfolds as part of performing embodiment (van de Ploeg 2003, 64). Still, coming from a perspective of Pickering's duality, the active part of the machine does make a difference. For example, the irritation and uncertainty that users experience can lead to frustration, and even impatience, with the process, and to people being distracted and/or adjusting on their own to deviate from the system's specifications. That, on the one hand, can hinder, or at least slow down, the whole process. On the other hand, here we see how users are adapting their behaviour to achieve a state of usability of the eGate in which the call for action can become routine. Although the incongruent working of the interior and exterior of the machinery represents a black box to the users, they feel it is more important for them to continue

"dancing" by reciprocal mimicry. Experiencing deceleration right up to stagnation is a result of distributed competencies. To Pickering (2017, 383) the decentred part of the interaction of "waiting" seems to put the human in a place of passiveness, stripped from any control of the situation. But as the users are tuning their practice to the perceived limitations of the technology as part of the oscillation of agency, the social also influences the technology. As we have shown, waiting has to be read differently from being an inactive part of the entities at play, as it can rather be seen as a passive competence. These adaptations might not point to causal effects, but they at least hold together the action sequence for using the eGates.

Thinking of the user in the way Sloterdijk suggests opened a more intense perspective on how to understand the human-machine interaction at play when it comes to the eGate and its interface. Sloterdijk emphasises that modern society is characterised by the paradox of simultaneous increasing and decreasing competence of human beings (2010, 11-15). While we are continuously developing our skills to navigate and use things we do not understand, we are at the same time incompetent when it comes to gaining knowledge of the black boxes that surround us. The inner worlds of the devices that dominate our daily lives are impossible to perceive and understand. The characteristic of those black boxes is that they turn to the user in a way that enables them to be used despite an "internal hermeneutic" (Sloterdijk 2010, 15). This is where user-focussed design steps in. The more complex the inner life, the more the interface needs to turn to the human being in order to draw the human to the device. Thus, the more incomprehensible the black box, the "more invitingly the box face must smile into the customer's natural face and signal to him: you and I, we can do it together" (*ibid.*, 15-16). Design then provides the tools for a continuing "sovereignty-simulation", where users buy themself the sovereignty of use through the design. From Sloterdijk's (2010, 17) point of view, these tools allow humans not to feel unconscious in the face of contemporary technological developments.

At this point we are confronted with one side of the aforementioned prism, as which border technologies can be understood. Looking at the microlevel of interaction can have an impact, even when the general developments of securitized border infrastructures (Trauttmansdorff 2022) and their filtering effects are discouraging. Of course, eGates have a corresponding agency in the real border context. They filter, grant or deny access. They practice exclusion and translate sovereign power. But when we see such a border technology as a manifestation of a biotechnological governance, are we able to value the insight as an opportunity in which human agency is possible and effective, so that there are moments of engagement, influence and creation? As our case study showed, by introducing a focus on usability, (laboratory) tinkering could bring back and secure human agency within this context, since it demonstrates that even automated systems rely on human bodies, their movements and other senses. This points to the relevancy of the users, instead of just focussing on the sovereign ambitions that are realised within the laboratory as Bourne et al. (2015) show. Akrich (1997, 211) suggests that "[i]f we are to describe technical objects, we need mediators to create the links between technical content and user". Therefore, testing arrangements such as the one we observed in our fieldwork can be spaces for meeting those mediators and an opportunity to turn them into spaces of challenge.

To accompany the tinkering in the laboratory means experiencing that they are not just spaces "for the production of scientific knowledge", but also spaces where the "distinction

between device [...] and laboratory [...] is a blurred one" (Bourne et al. 2015, 311). Looking at the laboratory offers insights on different stages of the co-functioning of the human-machine and research-site. In this spirit, Sarah Kember's (2014, 195) scrutinization of "smart photography" has shown that algorithmic facial recognition operates using traditional stereotyped categories (e.g., regarding ethnicity or gender). She then offers a constructive analysis by suggesting connecting algorithms which are able to break the inscription of bias. In doing so Kember transforms what Akrich, Pinch and Oudshoorn have been emphasising and what we have also tried to show: that there is no determinism in the use of technology. Rather we see all kinds of influences, whether stemming from users or innovators, that can modify the technology in question. As a matter of fact, the same applies to border technologies.

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Notes

[1] All translations of German quotations into English, both from the interviews and from pre-existing literature, are by the authors.

[2] We follow the concept of technography as it is coined by Werner Rammert, who characterised it as "a microsociology of technology, in which ethnographic methods of observation and description" are being further developed (Rammert and Schubert 2006, 19).

[3] For a critical reflection of the term "smart" border, see Trauttmansdorff 2022.

[4] For the purpose of confidentiality, all names and sensitive information are referred to as numbers in the order of interviews and observations.

[5] Although this irritation can almost certainly be attributed to the empirical setting in which the users were operating with a smart card, Sontowski describes irritations in his observations of eGate tests in the real border field, which he refers to as "misconducts" (2018, 2741).

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Interesting Worlds to Come. Science & Technology Studies Facing More-than-Human Challenges

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Abstract
This editorial by the board of STS Italia (The Italian Society for Social Studies of Science and Technology) introduces a Special Section of the Journal collecting a set of contributions to the IX STS Italia Conference, held in June 2023. The Special Section features an invited Lecture by Huub Dijstelbloem followed by a short commentary by Annalisa Pelizza. In addition, the Section includes the Crossing Boundaries "Drawing Bruno Together" and the Scenario "Bruno Latour and Artificial Intelligence" dedicated to Bruno Latour and both written by long-term colleagues, friends and exegetes of his work.

Keywords
STS Italia Conference; interest; more-than-human challenges; Bruno Latour.

1. Introduction

The IX STS Italia conference was held in Bologna, Italy, on 28-30 June 2023. It gathered scholars from Science & Technology Studies (STS) and related disciplines in a collaborative intel-

Figure 1.
Conference entrance and registration desk in Bologna.
Source: 9th Conference STS Italia photo report by Chiara Dazi.

lectual endeavour to explore "Interesting Worlds to Come", as indicated by the conference title.

These future worlds are interesting to us primarily as humans, holding promises of joys and challenges that await our engagement. However, the term *interesting* harbours an inherent ambiguity, its meaning being contingent upon the perspective of the observer. Recognizing this ambiguity prompts us to acknowledge that what we find interesting and why it matters are inextricably linked to the perspectives of those invested in the subject. Acknowledging this necessitates relinquishing a human-centred viewpoint and embracing a more comprehensive and diverse perspective as we navigate these impending worlds. The need to adopt this de-centred viewpoint has been underscored by events of the recent past years, demonstrating how our current and future challenges engage a myriad of interconnected entities that crucially extend beyond humanity to include non-human realms.

The emergence of a new viral life form, exemplified by the COVID-19 pandemic, has impacted various species. Recent outbreaks of conflict serve as reminders not only of the ongoing global wars but also of the devastation they bring to future generations of living beings and their environments, demanding extensive resource extraction to sustain them. Droughts and floods, witnessed in various parts of the world, including near Bologna a few weeks before the Conference, unveil not only the interdependence of distant regions but also the distinct, context-specific implications of climate change for diverse species, environments, and generations.

As these future worlds hold significance, they beckon us to take action, seizing opportunities and addressing challenges. This call to action resonates with a second meaning of the notion of interest, familiar to us as STS scholars. From this perspective, interest goes beyond mere awareness and acknowledgment, taking on the dimensions of agency, involvement, and intervention. Nevertheless, if we look at the outcomes of our interventions, history demonstrates the inadequacy of relying solely on humanity to address challenges that inherently are more-than-human. Humans, acting alone, struggle to meet the goals set by the IPCC, mitigate ongoing conflicts, and prevent future pandemics. We need help: the very essence of these challenges necessitates the formation of alliances that extend beyond humanity, alliances that facilitate enhanced understanding and more impactful intervention.

Evoking the concept of interest points distinctly to the intellectual lineage of the conference and this reference in the conference title is indebted to the concept of *interessement*, which Actor-Network Theory (ANT) illuminated approximately forty years ago. On one hand, ANT enlightened us about how both human and non-human entities participate in shaping the world we inhabit. On the other hand, ANT demonstrated that this world takes form only when these entities coalesce through processes of translation, involving their continual transformations, negotiations, and adjustments to the conflicting definitions of the issues at hand. In this context, alliances materialise through the acknowledgment that their alignment around a question, a piece of knowledge, an infrastructure, or an institution serves the interests of each involved party and can prove advantageous for all. However, achieving this alignment is the outcome of a protracted and costly process: *interessement* entails the active involvement of concerned parties in promoting specific perspectives on the issue at hand, thereby establishing devices that exist "in-between" these entities, in a way that is preliminary for the successful emergence and consolidation of these heterogeneous, more-than-human networks.

The conference unfolded within this conceptual framework, against the backdrop of the

current manifestations of the numerous geopolitical, health, and environmental challenges it aimed to explore. Over four hundred participants enlivened the 44 panels of the conference, delving into the diverse facets of these interesting processes. Discussions spanned from governance and participation in science and technology to artificial intelligence, from medical practices to epistemic authorities, and from border studies to energy and environmental issues. Not to forget the nexus between STS and art. The diverse origins of the participants contributed to a broader international spectrum of opinions and perspectives, too. While the majority came from European universities and research institutions, scholars from thirty-six countries in different continents shared their insights on the global challenges we all face and discussed the significance and urgency of advancing research and reflection, also directed towards intervention at the governance level.

The conference program was enriched by three plenary talks and three special thematic sessions. In the plenary talks, Huub Dijstelbloem delved into a specific aspect of climate change – climate migrations. Noortje Marres explored the public role of scientific expertise in governing the Covid-19 pandemic, while Paul Edwards discussed the temporal patterns of our current "techno-metabolism", focusing on the processes of energy and material resource consumption that drive the future evolution of the Anthropocene. Among the special sessions, a first one session aimed to support early-career scholars in publishing in high-quality journals. This was complemented by two thematic sessions: a Roundtable on *Taking Time, Shaping Time: Pacing Urban Climate Transitions*, which focused on the temporal dimensions of the new climatic regime and connected policy interventions at the urban level, and a Roundtable in memoriam of Bruno Latour, titled *Drawing Bruno Together* [1].

This issue of Tecnoscienza showcases some of these contents, featuring Huub Dijstelbloem's insightful lecture and a *Crossing Boundaries* section based upon the Roundtable titled *Drawing Bruno Together*.

While climate change is widely recognized as a transformative force, Dijstelbloem specifically examines its role in generating social inequalities in human (im)mobility. He argues that addressing these consequences non deterministically becomes urgent due to the limited capacity of traditional institutions, such as the nation-state, to cope with the resulting pressures. Traditional institutions, designed for a more stable and predictable world that has nearly disappeared, struggle to apply strategies like border enforcement to manage the significant demands of human migration. Current national state apparatuses are ill-equipped to handle the diverse, more-than-human actors involved in adapting our planet to the reality of climate change. In this context, Dijstelbloem underscores the strength of STS as a comprehensive body of knowledge well-suited to tackle issues of mobility and immobility in climate hotspots. Drawing on Latour's *Down to Earth: Politics in the New Climate Regime* (2018), Dijstelbloem links the overarching threat of the ecological crisis to the new climatic regime. His exploration, woven throughout the lecture, aims to propose directions for a renewed research agenda on human mobility, deconstructing elements that contribute to the tensions between mobility and immobility and challenging traditional perspectives on states, borders, and sovereignty. Ultimately, it fully acknowledges the interplay between humans, mobility and immobility, and the Earth itself.

The *Crossing Boundaries* section of the journal draws instead from the Roundtable titled *Drawing Bruno Together* organised during the Bologna Conference and from a preceding

Figure 2.
Huub Dijstelbloem during his lecture.
Source: 9th Conference STS Italia photo report by Chiara Dazi.

panel held during the 4S/ESOCITE conference in Cholula (Mexico) in December 2022. It gathers reflections and voices from those who collaborated with Latour extensively, those who had direct interactions with him, and those whose work was profoundly influenced by his thought. Instead of merely summarising or reporting on these events, the collection is geared towards delineating an intellectual platform that connects with Latour's enduring intellectual legacy. The text opens with Madeleine Akrich sharing memories of her extensive collaboration with Latour. Over two decades, she closely observed the development of groundbreaking contributions in sociology, anthropology, and philosophy. Following this, Huub Dijstelbloem delves into Latour's "magmatic" thinking, highlighting its transformative impact beyond STS. Annalisa Pelizza traces two crucial links in Latour's intellectual journey. The first one connects his thought back to his early engagement with the French semiotic discourse in particular with the "École de Paris" and Greimas' theory of enunciation. The second link explores Latour's connection with technofeminism and Donna Haraway's material-semiotics, emphasising a global dialogue emerging in the late 1980s. Finally, Paolo Landri underscores Latour's conceptual framework's transformative potential in education, emphasising interdisciplinary connections fostered by embracing Latour's ideas.

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Notes

[1] The full conference program and abstracts are available on the conference's website: https://eventi.unibo.it/stsitalia2023/.

Moving the Immovable: Climate Change and the Multiple Tensions between Mobility and Immobility

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Abstract
The lecture examines the emergence of the research field of climate migration from a philosophy of science and technology perspective. It explores the tensions between mobility and immobility by discussing three specific technologies and infrastructures that emerge from the notion of climate migration and push mobility to the extreme: interventionist policies that encourage managed retreat, experimental digital technologies that promote circulation, and a proposal for a climate passport. It then considers implications of this paradigm of mobility for STS, focusing on immobility as a concept that can deepen and challenge our understanding of a trinity of states, sovereignty, and territory under conditions of climate change and mobility. By reconceptualizing the relationship between mobility and immobility, the lecture proposes a nuanced and refined alternative to the emphasis on motion, movement, and mobility, with the aim of contributing to the discussion of how climate (im)mobilities and Anthropocene (im)mobilities unfold.

Keywords
climate migration; (im)mobility; extreme infrastructures; mobility paradigm; Anthropocene mobilities.

1. Introduction

Composite terms, concepts that combine different notions like "platform economy", "identity politics", or "urban mental health", do several things. They define a new phenomenon, suggest a relationship between the composing terms, often a causal relationship, and point to a direction in which the current situation in economics, politics, or health problems is moving: the emergence of platforms, expressions of identity, and urban environments are putting pressure on existing ideas about economics, politics, and health. The same is true of the term "climate migration". As a relatively new concept or subcategory or specification of environmental migration, it calls attention to a presumably novel phenomenon, namely that existing forms and patterns of migration will be affected by climate change, that new categories of migrants will emerge, and that the number of migrants is likely to increase due to the devastating effects of climate change. Direct effects, such as drought incidence, increased cyclone intensity such as by hurricanes and typhoons, and sea level rise but also heath waves

and floodings, as mentioned by the IPCC (2023), that will damage communities, villages and cities, complicate agriculture, and economic trade or human existence directly, because it will deprive entire regions of water, or will make life simply too vulnerable or even impossible. But there are also indirect consequences, because climate change can be a source of conflict, or because states fail to take the required measures, willingly or not, or because economic and political investment simply anticipates the consequences and withdraws. Here we already see the beginning of the complications of the notion of climate migration.

The scientific discussion and political consequences of the concept of climate migration can be described by applying the STS approach of controversy studies. To contribute to the conference theme "Interesting Worlds to come. Science & Technology Studies facing more-than-human challenges" of the 2023 STS Italy conference in Bologna, I will first unpack the notion of climate migration to see how STS can help understand the development of an emerging field of knowledge, policy, migration, and climate adaptation management. Thereafter I will discuss some of STS key concepts and assumptions as well, namely about what we exactly mean when we say we study networks and relationships, how we distinguish between relationships and causal relationships in those networks and which kinds of causal relationship we use. For that reason, I will focus on how STS research engages with the notion of mobility, not only as an object of research but also as an ontological assumption, or perhaps sometimes even as mobility-bias. My claim is not that STS should be seen as still following the "mobility turn" in the social sciences since the 1990s (Urry 2000). If only because the real "mobility turn" took place ages ago when the Aristotelian metaphysics of the "unmoved mover" and the subsequent Christian theology was replaced by the dominant concepts of movement and event (Blumenberg 1983; 1996). As Peter Sloterdijk once put it, "nowadays, only real estate brokers believe in immovable property" (Sloterdijk 2020, 50). And even that statement is questionable today.

Attending to the tensions between mobility and immobility is also a way of advancing the political theory component of STS. Critical reflection on the notion of mobility is also required as the control over mobility is one of the key aspects of today's state control – and international cooperation between states. John Torpey (1999) developed a powerful analogy in his book *The Invention of the Passport: Surveillance, Citizenship and the State*. Drawing on arguments from Marx and Weber, he sought to demonstrate that modern states and the international state system of which they are part have deprived individuals and private entities of the legitimate means of movement (Torpey 1999, 5-6). While Max Weber argued that states expropriated the means of violence from individuals and private entities, Torpey claims that modern states have acquired a "monopoly on the legitimate means of movement". Whether states have acquired a monopoly on the control of mobility in the same way that they have acquired a monopoly on violence is still the subject of academic debate. What is becoming clear, however, is that climate change is putting pressure not only on the presumed control over the movement of people and the situations of migration, refuge, exile, and statelessness, but also on the situation of being stuck and stagnant. Meanwhile, the relationship between climate change, mobility and immobility is inextricably intertwined with a configuration of other factors that complicate the determination of direct and indirect causes and consequences. STS research seems well placed to explore this area, provided that it succeeds in developing a refined perspective on the understudied notion of immobility.

2. Unpacking climate migration with STS

In *Down to Earth: Politics in the New Climate Regime*, Latour (2018) argued that "migrations, explosions of inequality, and the New Climate Regime" are "one and the same threat". "The climate crisis", he wrote, "is forcing people they do not welcome to cross their forties; hence the response: 'Let's put up impenetrable borders and we'll escape from the invasion!'" However, he continued, "the New Climate Regime has been sweeping across all our borders for a long time, exposing us to all the winds, and no walls we can build will keep these invaders out". But, he claimed, "neither state sovereignty nor inviolable borders can take the place of politics any longer" (Latour 2018, 8). The political question, according to Latour, is "how to reassure and shelter all those persons who are obliged to take the road, even while turning them away from the false protection of identities and rigid borders?" (Latour 2018, 11). "How", he asked,

> can we reweave edges, envelopes, protections; how can we find new footing while simultaneously taking into account the end of globalization, the scope of migration, and also the limits placed on the sovereignty of nation-states that are henceforth confronted by climate change? (Latour 2018, 11)

If indeed this is the big question we are facing, I propose we start with unpacking the concept of climate migration. Climate research and migration research are broad and mixed disciplines themselves, existing of all kinds of older and newer fields and approaches. Although there is not much overlap between the fields, in terms of scientific approaches and scientific researchers, they do have something in common: both can be considered as crisis-disciplines, fields of research that operate at a moment in time and study situations, patterns and development, interventions, causes and effects where things are in crisis, either because of the devastating consequences of climate change and the seize and urgency of the measures that are required in order to prevent things from even being worse, or because of the terrible humanitarian consequences of some of the causes of forced migration – violent conflicts, discrimination, prosecution, death sentences and the unworthy circumstances and sheer violence migrants meet when trying to reach other destinations.

The two fields meet, or rather, the study of migration is situated in a broader context of scarce resources, vulnerable regions, changing environments, political instability, and conflicts, when it concerns the relationship between climate change and migration. The combination of the research fields of climate change research and migration research connects the latter to what Edwards (2013) called "the vast machine", the development of climate models, including simulation models, reanalysis models, and data models and the theoretical, methodological, and infrastructural integration of various fields of study, including weather and climate observing systems.

The relationship between climate change and migration is complicated and at certain points even highly contested. One can even argue that it is hardly worth paying attention to this notion because migration researchers and environmental policy scholars already carefully deconstructed the concept. In a 2019 Comment in *Nature Climate Change*, Ingrid Boas and colleagues identified the most important myths. Below, I will focus on three of them. First, there

is already a considerable body of evidence to suggest that migration is not driven by climate change alone. Instead, it is influenced by a mix of climatic, socio-economic, cultural, and political factors (Boas et al. 2019, 902). Second, it is often assumed that climate change will lead to increased international mobility, especially to European and North American countries. However, empirical evidence suggests that most climate-related mobility tends to occur at the national or regional level (Szaboova 2020, 6). Third, climate change does not always lead to mobility. While it may lead to increased willingness to move, climate change may also undermine the vital capital and resources needed to migrate, leaving some of the most vulnerable and poorest unable to move in response to climatic and environmental risks (Black and Collyer 2014).

These arguments seem to consign the concept of climate migration to the academic dustbin. However, there is still an argument to be made in favor of the notion of climate migration, namely the commonsense notion that people are already being confronted with the consequences of climate change, and there is no doubt that these consequences are only going to get worse. It may be true that "the discourse of apocalyptic climate change-induced mass migration is now past its prime" because:

> an ever-rising number of studies shows [...] that relations between climate change and human migration are often indirect, small-scale, and taking shape in context-specific ways, influenced by a host of other socio-economic and political factors. (Boas et al. 2022, 3365)

However, detecting the refined relations between climate change and human mobility in all kinds of context, situations and events will only become more important as the debate shifts towards anthropocene mobilities (Baldwin et al. 2019). The challenge ahead is to be more precise about the kinds of relationship between climate change and migration, especially because the notion of climate migration has a political connotation. The term has a performative effect. It rings alarm bells, not just by introducing this new category but also by adding the numbers. To explain this effect, I will first consider the theoretical construction of climate migration research. After that, I will discuss three possible consequences – of political interventions, of technologies and of infrastructures – that this way of thinking can lead to.

3. The under-explored notion of immobility

Despite the attempts to debunk the myth of climate migration, there is an increasing amount of literature arguing climate change will stimulate mass migration from vulnerable regions in low-income countries to other destinations. Various politicians and scientific policy advisors have raised the red flag. Lord Stern, author of the Stern Review, was quoted in *The Guardian* in 2013, stating that:

> Hundreds of millions of people will be forced to leave their homelands because their crops and animals will have died. The trouble will come when they try to migrate into new lands, however. That will bring them into armed conflict with people already living there. Nor will it be an occasional occurrence. It could become a permanent feature of life on Earth. (McKie 2013)

In his 2015 State of the Union speech, European Com¬mission president Jean-Claude Juncker stated: "Climate change is one of the root causes of a new migration phe¬nomenon. Climate refugees will become a new challenge – if we do not act swiftly" (Juncker 2015). The Economist, on Nov 18th 2022, wrote that "Climate change is likely to increase migration" but rightfully added that "three-quarters of such migrants stay within their own country" (Dobbs 2022). Assumptions about a causal link between global warming and migration are also found in the scientific literature. Based on their research (Xu et al. 2020) Scheffer estimates that global warming is likely to drive billions of people out of the so-called "climate niche" in which humanity has flourished for millennia (Carrington 2023). Also the popular-scientific literature on climate change and migration is increasing, see for instance Gaia Vince's (2022) *Nomad Century. How to Survive the Climate Upheaval*. Vince begins with a prediction of a dystopian future, based on scientific projections of a world that will soon be warmer than at any time in tens of millions of years. The consequences will be devastating. Coastlines altered by rising seas and stronger tropical storms, forests ravaged by wildfires, drought-stricken fields left barren, and deserts expanding to swallow villages and towns. Other communities will be wiped out by terrible floods or abandoned for lack of rainfall. As a result, Vince argues, humans will do what we have done throughout our evolutionary history: we will move. But this time it will be in our billions, on an unprecedented scale. At this point Vince's story becomes utopian. According to her, the coming migration of billions of people from the tropics to the northern hemisphere can be planned. New cities will have to be built to house the climate migrants and give them a chance to build new lives in Alaska, Canada, Greenland, northern Europe and Russia, as well as in Patagonia, Tasmania, New Zealand and Antarctica, as they leave warmer latitudes in Asia, Africa and Latin America. She is extremely optimistic about the possibilities of successfully integrating migrants into their new communities through enlightened policies.

Such optimism is a rarity. More to the point of this lecture, assuming so much causality between climate change and migration is also exceptional – and questionable. There is some general agreement about which kinds of countries are likely to be affected most by climate change and out-migration. The least developed countries (LDCs), landlocked developing countries (LLDCs) and small island developing States (SIDS) are among the most vulnerable groups of countries in the world. They are disproportionately affected by the negative impacts of climate change due to their structural constraints and geographical disadvantage. In 2016, 13 out of the 15 countries with the highest vulnerability to natural hazards were from the LDCs, LLDCs and SIDS groups (IOM 2019). But it is misleading to suggest a direct re¬lationship between climate change and migration. The effects of climate change depend on the local or regional conditions, the ways a region is susceptible to change, whether resources will be affected, and whether the provision of food, agriculture, housing, health care, and many other infrastructures will last (Benveniste et al. 2022). The form and intensity of the consequences of climate change highly depend on responses by governments and international organizations, measures that are or are not taken. As a cause of migration, climate change, in short, is not an independent driver but part of an assemblage of life circumstances, development, environmental conditions, state governance, and interna¬tional relations. The terminology is contested as well. Previously, the notion of climate refugees briefly prevailed,

but disappeared quickly and never made it into a policy term as it does not exist as a category in international law. The IOM and the United Nations suggest speaking of cli¬mate migrants which does not require a legal formulation. The UNHCR, the UN Refugee Agency, prefers the notion of dis¬aster displacement and environmental migrants. Climate migration or Climate Change Induced Migration (CLICIM) is a very general term, with quite some complications as we just saw.

Given this taxonomical variety and the unclarity of the relationship between different terms, different forms and situations of climate change and different modes of (im)mobility, integrating climate change as a driver of migration into migration research and, to some extent, to pursue an integration and synthesis of climate and migration research, is complicated. Not only due to practical and methodological problems, but also due to some central assumptions in migration research. As Pisarevskaya, Levy, Scholten, and Jansen (2020) have pointed out:

> As a broadly-based research field, migration studies has evolved at the crossroads of a variety of disciplines. This includes disciplines such as sociology, political science, anthropology, geography, law and economics, but increasingly it expands to a broader pool of disciplines also including health studies, development studies, governance studies and many more, building on insights from these disciplines. (Pisarevskaya et al. 2020)

Meanwhile, migration research has been criticized for lacking a general theory and for being based on – or biased by – some key assumptions: first, it is state-centered; second, it reproduces colonial representations; and third, and this is the point I want to focus on, it suffers from a mobility bias.

The latter may sound strange: is accusing migration research of a mobility bias not the same as saying that natural science pays too much attention to physical nature and that sociology focuses too much on the social? After all, isn't mobility the central object of research? Well, it is, but just as Latour in *Reassembling the Social* (2005) once blamed the social sciences for misunderstanding the social and mistaking the explanandum for the explanans, I would argue that immobility is just as important for understanding migration patterns as mobility, and we can't fully explain the former by the latter.

A first step to understand this issue is by taking a closer look at the contract between nation-states, territory and sovereignty. An argument brought forward in migration research is that the notion of "migration" itself is a particular way to conceive of human mobility, namely as movement in a world governed by states, jurisdictions, and borders regimes. The risk of designating human mobility as "migration" is that it naturalizes the border. The by now famous saying holds that "if there were no borders, there would be no migration – only mobility" (de Genova 2017). On the other hand, it has been argued that "if there were no state borders, other kinds of borders would likely emerge, in different shapes, at other locations" (Dijstelbloem 2021, 16-17). The core of the discussion is that migration studies are held captive in a misleading picture that naturalizes the nation-state. The existence of states is taken for granted and situated as a starting point to analyze human mobility. However, territory and sovereignty and "the control over the means of movement" as Torpey called it are much more loosely related and come in more variegated combinations than is often

assumed (Dijstelbloem 2021). Two assumptions often underlie the literature on state formation, sovereignty, borders and migration. The first is that the modern form of state power and the relationship between nation-states and borders was born in the European state, starting with the Peace of Westphalia. The second is that this form of governing and controlling mobility has spread globally from the West (Vigneswaran 2020, 2). In contrast, institutional-historical archival research on the development of international migration policy suggests that "extra-European actors played a significant role in both originating and defining the nature of European sovereign territorial and transnational mobility norms" (Vigneswaran 2020, 3). Territorial migration control also arose outside Europe and migration policy in European countries was more the result of international negotiations and exchanges than bearing a Westphalian mark (Dijstelbloem 2021).

This state-focused legacy continues in migration research regarding the issue of immobility. To clarify that, I will attend to some recent proposals that aim to contribute to theory construction in the field and show how immobility is conceptualized as an unmovable immobile. Of course, there are many studies that deal with immobility: refugee camps in Kenya, Bangladesh, Jordan, Tanzania, or Pakistan where migrants are trapped for years, forced immobility, the relationship between immobility and time, and especially during the Covid-19 pandemic with its lockdowns and travel restrictions, the issue of immobility became more important. But the question is if we can explain immobility as a category on its own.

To answer that question, let us take a closer look at the recent development of the migration research field. The discussion has been fueled by Schewel (2020). She recalls the basic elements a satisfactory theoretical account of international migration ought to contain. According to Massey et al. (1999) concluded there are four basic elements:

1. The structural forces that promote emigration from origin areas;
2. The structural forces that attract immigrants into destination areas;
3. The social and economic structures that connect origin and destination areas;
4. The aspirations and motivations of those people who respond to these structural forces by migrating.

And indeed, theoretical frameworks based on these elements have proven to be succesful. Migration research left the older push-pull models and rational choice cost-benefit analysis according to which people move from low income to high income countries behind. Instead, it opted for a more multidimensional model. However, according to Kerilyn Schewel:

> these elements alone are insufficient to explain real-world migration trends. The structural forces that constrain or resist migration in and between origin and destination areas, as well as the aspirations of actors who respond to these same forces by staying, must also be included. (Schewel 2020, 329)

In recent work, De Haas (2021, 25) has proposed a proper theory of migration that also addresses the category of non-migration (Figure 1).

The theory is erudite and ambitious but can still be questioned. For instance, the different concepts that are related in the model come from very different disciplines and approaches. The idea of distinguishing between a negative and a positive sense of the term "liberty" was

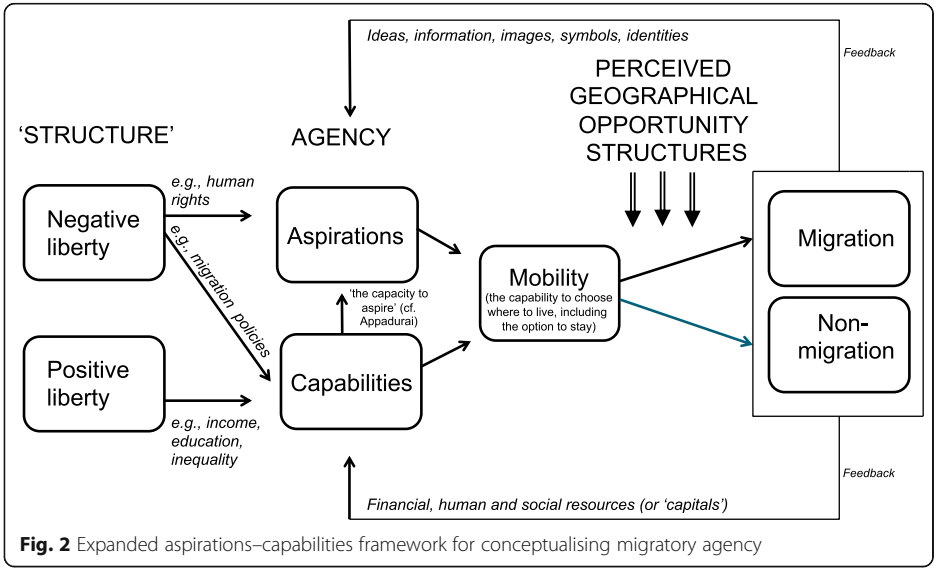

Fig. 2 Expanded aspirations–capabilities framework for conceptualising migratory agency

Figure 1.
De Haas (2021, 25)

proposed by Isaiah Berlin. "Aspiration" is a category that requires social science research and often ethnographic fieldwork. The capability approach is a social justice approach developed by Sen and Nussbaum to criticize traditional economic models. Notwithstanding this rather composite and varied origin, the model follows the structure of theory construction in the social sciences. However, according to Schewel (2020, 335): "An important limitation of [...] De Haas's work is [the] relative neglect of the category and determinants of voluntary immobility". For that reason, Schewel (*ibid.*) introduced a fourth (im)mobility category to the framework, namely that of acquiescent immobility (Figure 2). The category of acquiescent immobility highlights "those who do not wish to migrate and are unable to do so". The word acquiescent implies non-resistance to constraints, its Latin origins meaning "to remain at rest".

The tentative conclusion at this point is that it is a highly complicated endeavor to combine different research fields, such as climate science and migration studies, without questioning the central assumptions of the research fields and identifying possible theoretical constraints or blind spots that might hinder future research. Ignoring the notion of immobility not only leads to a potentially limited view of migration and overstated assumptions about the causal relationship between climate change and human mobility, but also does injustice to the different aspects, dimensions, and modes of immobility.

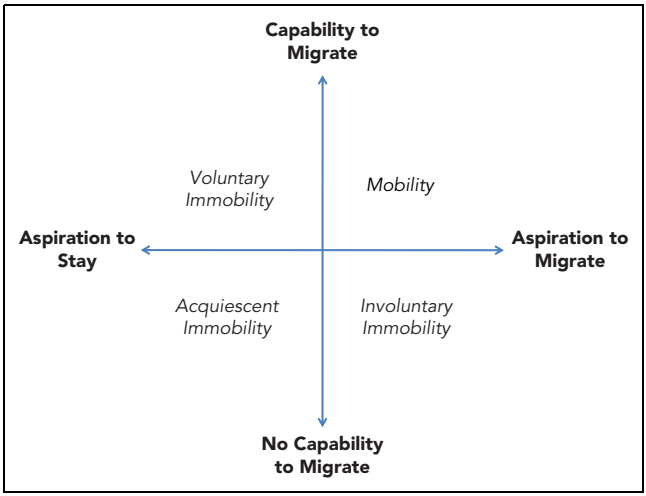

Figure 2.
Schewel (2019, 335)

4. Extreme infrastructures

The relationship between mobility and immobility returns in the discussion about the specific technologies and infrastructures that are generated from the notion of climate migration. This is the point where the notion of what I call "extreme infrastructures" enters the stage. The notion of "extreme" combines two connotations, namely with regard to intensity in the meaning of exceeding the ordinary and becoming "radical" or aiming at a "maximum" or "pushing to the limits" and a spatial meaning as in situated at the farthest possible point or being at the outer boundaries, as is also apparent in the Latin origins of the term "exterus" meaning "outer" and "extremus", "outermost". With extreme infrastructures I refer to technologies, instruments and material security policies that create, control or displace borders, for example by the externalization of border control, and do so in extreme ways, by pushing the boundaries of legitimate state actions by moving jurisdiction to other countries or crossing legal boundaries by violating fundamental rights. Obvious examples concern the wall in Europe, pushbacks, and the violence used in the externalization of border control for instance by the deals between the EU and Turkey and the one with Tunisia that is being developed these days (Dijstelbloem 2021).

When it comes to climate change, migration and the relationship between mobility and immobility, the extreme consists of trying to make the unmovable move, pushing the mobility paradigm to the limit by creating ever more means of movement while ignoring the constraints of immobility. Three potential infrastructures that push mobility to the extreme come into mind:

1. Managed retreat;
2. Humanitarian experimentation and protracted migration;
3. Climate passports.

4.1 Example 1: Managed retreat

The first example of how the unmovable is encouraged to move concerns so-called managed retreat. Managed retreat involves the purposeful, coordinated movement of people and buildings away from risks, in this case risks caused by climate change. As always, we should be wary of the word "manage". All too often, especially in the context of migration, it is a euphemism used to mask forceful interventionist policies with far-reaching consequences. The phrase "managed retreat" was coined by coastal engineers in the early 1990s (Pethick 1993). It initially referred to the removal of infrastructure, such as sea walls, so the rising ocean could encroach, particularly in Australia and the UK. Nowadays, the term is much more widespread, although sometimes the much gentler notions of "resettlement" and "managed realignment" are used as well, as are the more aggressive notions of "strategic advance".

Managed retreat comes in different forms, varying from buyouts to community relocation when entire towns are being picked-up. According to Siders et al. (2019) "Retreat has been seen largely as a last resort, a failure to adapt, or a one-time emergency action; thus, little research has focused on retreat, leaving practitioners with little guidance". According to them, "such a narrow conception of retreat has limited decision-makers' perception of the tools available and stilted innovation". For that reason, they "propose a reconceptualization of retreat as a suite of adaptation options that are both strategic and managed".

The tension between immobility and encouraged or even forced mobility can have severe consequences, because they are often based on a utilitarian logic that easily disregards the rights, concerns, and aspirations of individuals. Displacement of communities can cause significant disruption, uprooting people from their homes, neighborhoods, and social networks. It can lead to the loss of community cohesion, cultural heritage, and a sense of belonging. Community relocation disproportionately affects marginalized and vulnerable populations who may not have the resources or support to move to safer areas. The acquisition and relocation of property from individuals or communities is often required for managed retreats. Respecting property rights and providing fair compensation can be complex and contentious. Determining how to value property, addressing legal issues, and ensuring that property owners are adequately compensated can be challenging – and so is ensuring that decision-making processes are transparent, inclusive, and participatory to avoid excluding or neglecting the voices and concerns of affected populations.

4.2 Example 2: Humanitarian experimentation and protracted migration

The second example of moving the immovable concerns the experimentation with data that takes place upon displaced people and populations. In this case, the paradigm of mobility returns as a means of creating financial circulation, while the circulation of people is at a standstill, with displaced persons and populations remaining in refugee camps. The stimulation of circulation takes place with experiments with humanitarian data. As STS scholars know all too well, experimentation has left the lab for long and has become part of business, government, and NGO policies. It takes the shape of developing data supported decisions based on online experiments with users as conducted for instance by Booking.com[1] or living labs in cities (Tay-

lor 2020). It can also take place in regulatory settings, such as regulatory sandboxes that offer frameworks for experimentation. In the humanitarian context, examples of "humanitarian experimentation" include biometrics and data modelling (Sandvik et al. 2017), "humanitarian wearables", i.e., "smart devices that can be placed on or inside the bodies of aid beneficiaries for many purposes, including tracking and protecting health, safety and nutrition" (Sandvik 2020) or remote sensing imagery from satellites or drones in the case of natural disasters or conflict situations. Whereas proponents emphasize that data gathering from for instance cell phones, modeling, and machine learning improve targeting risk groups and support humanitarian aid (e.g., Aiken et al. 2022), others warn for the ethical risks and argue a new form of extraction, datacolonialism (Thatcher et al. 2016) or technocolonialism might be at stake (Madianou 2021).

Situations of protracted migration lend themselves particularly well for this kind of humanitarian experimentation. According to the UNHCR, "protracted refugee situations are those in which at least 25,000 refugees from the same country have been living in exile for more than five consecutive years. Refugees in these situations often find themselves trapped in a state of limbo: while it is not safe for them to return home, they also have not been granted permanent residence to stay in another country either" (UNHCR 2020). Tensions between mobility and immobility, fixity and flux, are likely to arise when collaborations with tech companies and industries, such as credit card and other financial companies, are aimed at stimulating certain forms of financial circulation, while the human circulation remains stuck.

4.3 Example 3: Climate passports

The third and final example of making the unmovable movable concerns a well-known object: the passport. Passports are a unique combination of an identify document and a travel document. Whereas some governments for security reasons are increasingly in favor of disconnecting the two functions of the document, and whilst during the Covid-19 related travel restrictions we saw the rise of all kinds of travel certificates combined with test results and vaccination certificates, the WBGU, the German Advisory Council on Global Change proposed the climate passport in 2018 (WBGU 2018). Similar ideas, such as the proposal to distribute Climate Humanitarian Visa, have been made by other scholars (Matias 2020) but the idea of climate passports has been specified by Kira Vinke in her book *Sturmnomaden* (2022).

The idea of the climate passport is based on the Nansen Pass, for which the Nansen International Office for Refugees was awarded the Nobel Peace Prize for implementing this project in 1938. The Soviet government's decision in 1922 to revoke the citizenship of 800,000 Russian citizens living in exile inspired the idea of the Nansen Pass. During and after the First World War, these people were dispersed throughout Europe as refugees from the Russian Civil War, or as exiles fearing repression by the newly formed government. To address this deficiency, the "Arrangement Concerning the Issuance of Certificates of Identity for Russian Refugees" was negotiated in Geneva from July 3 to 5, 1922, under the chairmanship of the then High Commissioner for Refugees of the League of Nations, Dr. Fridtjof Nansen. To enable the stateless people to move across borders in their search for a new home, the ratifying states were obliged to issue them with passports. In this way, the trapping dynamics of statelessness were overcome (see Los 2020).

The proposal of the German Advisory Council on Global Change for a climate passport is based on this idea. On the one hand, this idea reads as a proposal to revive what John Torpey called the control of states over the means of movement. On the other hand, it can be argued that the selection of states to which this passport hypothetically refers is not based on the notion of territory, but on an anthropocenic terrain. The passport is supposed to grant holders not only the right to be admitted to other countries, but rights similar to citizenship. The WGBU makes a distinction in order to identify those states that are obligated to receive refugees and those individuals who would be entitled to a passport.

Which countries should receive migrants? The WBGU suggests that the 10 countries with the highest historical cumulative emissions and the 15 countries with the highest per capita emissions should be primarily responsible. And which migrants should be the recipients of the climate passport? Here the WBGU applies a different criterion. Although all those affected should be entitled to such a humanitarian instrument, the first step will be to protect those people who will be affected by climate change at the earliest possible stage. But this will be based on an expert review process.

From the point of view that mobility and immobility are inextricably linked, the granting of a climate passport to migrants must have consequences for those who do not move, including those in the host countries. The mobility rights of the inhabitants will also have to be affected to allow for the slightest bit of symmetry. This is where questions of climate justice, rights and privileges come into play again, but now in the context of mobility. More importantly, grounding the notion of a passport and the right to mobility on carbon footprints and historical cumulative emissions, rather than on the contract between states, sovereignty, territory, and borders, leaves behind the notion of control over the means of movement and replaces it with a concept of anthropocenic terrain on which human mobility and immobility take place.

5. Mobilizing the concept of immobility

Now that we have analyzed the emphasis on mobility in migration and climate migration research, and explored the possible consequences of proposing specific techniques and infrastructures that elaborate the mobility paradigm, the inevitable question is how the development of STS itself as a research field relates to the so-called mobility turn in the social sciences. Seeing evidence of complicity is tempting. Actor-network theory, for instance, with roots in Deleuzian philosophy and semiotics, exchanged a foundational philosophy or a social science approach concerned with structures at different layers for a “plane of immanence”. Translation, circulation, articulation became key notions to debunk the relationships between subjects and objects and focus on the coming into being of relationships in a non-reductionist way. These notions imply that every relationship is a dynamic relationship in which a certain interaction takes places. Something is exchanged, transferred, transformed when humans or nonhumans meet. On the other hand, Latour and many others always emphasized the relationship between mobility and immobility, for instance with the notions of “Centers of calculation”, “Obligatory passage points”, “Immutable mobiles”, “Hybridization and purification”, and “Circulating reference”. They refer to events where mobility and circulation

of facts, artefacts, people, and all possible combinations between them go hand in hand with moments of stabilization and solidification. The same is true for those authors in the fields of international relations and security studies who work closely with the science and technology studies. To name a few, Barry (2001) studied the infrastructural movements of the EU as a technological zone in *Political Machines*; in the two volumes of *Making Things International* Salter and colleagues (2015; 2016) considered the movements of things and how they have expanded our notions of globalization by investigating *circuits and motion* and catalysts and reactions. De Goede traced and detected the interactions in security and finance to counter terrorism in terms of a chain of security (2018). Pelizza (2021) emphasized the ruptures, friction and translations in infrastructures that organize asylum requests, data management of displaced people and information flows about mixed migration. The author of this lecture is also guilty as charged, because in *Borders as Infrastructure* (2021) I argue that borders themselves should be thought of as mobile entities. So, to support the STS case – and my own – I think it is misleading to say that STS is entirely based on the mobility paradigm. That is to say: I think there is a preoccupation with mobility as an object of study. We study movement, circulation, mobility, networks, transitions, transformations, and translations. Theoretically, however, things are more nuanced, and the most sophisticated STS approaches try to precisely discern the relationships between what is or will be mobile and what remains, has been, or will be immobile[2]. The challenge is that we can be more precise about what Brown called the tension between fixity and flux in STS (Brown 2009, 180-183).

If this is the paradigmatic position of STS, then the field seems sufficiently equipped to think with and against the notion of climate migration, and in particular to offer a nuanced and refined alternative to the emphasis on motion, movement and mobility. Motion and movement are central concepts and topics of research in the social sciences, in science in general, and climate research and migration studies are no exception to this. This dominance concerns both a conceptual interest, in which movement figures as an ontological, epistemological, or political blueprint of the world, and an empirical interest, in which research focuses on specific phenomena related to movement, such as migration or the development of infrastructures. The purpose of this lecture was to formulate an amendment to this mobility paradigm. Over-emphasizing notions of motion and mobility runs the risk of neglecting situations of immobility, for instance when people are stuck or unwilling to move. Instead of giving primacy to the notion of movement, the reconceptualization of the relationship between mobility and immobility, conceptually and empirically, deserves more attention as the discussion of climate mobilities and anthropocene mobilities unfolds (Adams 2016; Baldwin et al. 2019; Boas et al. 2022; Schewel 2020; Wiegel et al. 2019). The aim of the above was to contribute to the exploration of the relationship between mobility and immobility in times of climate change and changing environments. Attending to these issues also allows for deepening our understanding of how the trinity of states, sovereignty and territory is affected (Dijstelbloem 2021) and the resulting regime of rights and citizenship in times of global warming (Chandler 2019, 386).

If we use the two constituent terms of STS, "science" and "technology", as a lens to analyse the notion of climate migration in terms of the emergence of a field of research and as an interventionist program, does this mean that the concept should be abandoned? As a concept,

climate migration appears in three different forms. First, in its most factual form, as a name for a phenomenon that exists, that can be described and explained, and that can be studied and intervened upon. In the second, as an alarmist term, the concept is waved as a red flag, to emphasize migration is likely to increase and that more border security is needed. Thirdly, climate migration is seen as something that, when it occurs, should be facilitated, or even encouraged on a humanitarian basis to promote the movement and circulation of people. However, there are important risks and more generally the term over stresses the causal relation between migration and climate change. For that reason, we need a more plural approach that does justice to the variety of interactions between different forms of climate change, its entanglement with policy interventions, socio-economic aspects, conflict situations and material circumstances, and different forms of (im)mobility. We need to pay attention to the multiplication of categorizations, and the relationship between mobility and immobility that is at stake, such as in the examples of managed retreat, humanitarian experimentalism, and climate passports. What do mobility and immobility mean in those contexts? How are they related? How do they constitute each other? What does "becoming" mobile or immobile mean? What does "remaining" mobile or immobile mean? A refined understanding between mobility and immobility is required to deal with the challenges of climate change and human (im)mobility. An important reason to pay attention to immobility is not only because it is empirically and theoretically understudied as a category, and because it is an important issue in thinking about migration and climate change. Conceptually, the concept of immobility has the potential to be a counterweight and a resistance to too much thinking in terms of mobility. However, especially when climate migration becomes a security policy concept, more attention to the relationship between theory construction and the development of infrastructures is required.

As hopefully demonstrated above, an STS analysis of the notion of climate migration shows that applying a mobility perspective and reproducing key assumptions of migration research that are state-centred, pursue colonial legacies and tend to disregard the immobility of people, as in proposals for managed retreat, humanitarian experimentalism, and climate passports, runs the risk of prioritizing movement over attachment to place. It may be going too far to say that movement and mobility are the key concepts driving research on migration, but otherwise it is no exaggeration to say that research on immobility and fixity is underdeveloped. This does not imply that what is needed now is a counter turn, an anti-Copernican backlash against mobility, or a revaluation of a grounded and territorial ethic that assigns rights to inhabitants and residents. The direction that needs to be explored further is twofold. The first task is to further develop the science and technology perspective on how theory construction takes place and how explanations or causal relations are determined when different disciplines or research methodologies are integrated, such as in the case of climate science and migration studies. The second task is to recognize immobility as a reservoir of potentialities, and how attachment to land, place, and location can be understood in relation to mobility and movement.

Having analysed the emergence of the research field of climate migration from a philosophy of science perspective in the first part and having discussed different infrastructures and technologies, namely an interventionist policy, an experimental digital technology and a proposal for a document, in the second part, and having reflected on the dominance of the notion of mobility and the question of whether STS itself suffers from a mobility paradigm, the

task ahead is still complicated and demanding. The exploration that has taken place so far can hopefully lead to some guidance to navigate the next set of questions. These questions include how to unfold the potential of immobility, how to typify the differences between different modes of immobility, how to define the different modes that relate movement and flow to immobility, and how to identify the transfers that occur between the two. Addressing these questions will hopefully contribute to a deeper understanding of what it means to be attached to a place under conditions of climate change. The tensions between mobility and immobility will challenge the trinity of states, borders, and sovereignty and call for an Anthropocene view on the connection between humans, mobility and immobility, and the earth.

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Notes

[1] See https://booking.ai/.

[2] A fine example is the work by Matthias Leese and Stef Wittendorp (2018), who attend to immobile infrastructures and argue that a focus on security and mobility is not a plea to get rid of the category of fixity.

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On Causality, the Modern Contract and Inertia in "Climate Migration"

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Abstract
Commentary to the Lecture "Moving the immovable: Climate change and the multiple tensions between mobility and immobility", by Huub Dijstelbloem (this issue).

Keywords
climate migration; causality; modern contract; denationalization; (im)mobility; inertia.

When first listening to Huub Dijstelbloem's keynote lecture, I was enticed to read his contribution about "climate migration" as an attempt to expose STS' tendency to stress contingency and what he calls a "mobility bias". After all, what more intrinsically mobility-biased than replacing a sociology of the social with a sociology of associations (Latour 2005), which requires following the movement of an element from one assemblage to another? Dijstelbloem indeed proposes to advance the political theory component of STS, and resorts to established social science conceptualizations of state and structure.

Yet more than to an opposition, Dijstelbloem is pointing to a constitutive trait of STS, at least since when in 1981 Aaron Cicourel and Karin Knorr-Cetina included representatives from the field in their edited book on the integration of micro- and macro-sociologies (Cicourel and Knorr-Cetina 1981). Explaining both transformation and durability has been a non-secondary goal in STS scholarship, as much as sidelining determinism has been. More recently, STS attempts to problematize the co-constitution of emergency and stability have emerged from the dialogue with neighboring disciplines. In their introduction to a special issue on "scripts of security", for example, Aradau and Pelizza (forthcoming) show how contingency and obduracy represent two extremes capable of productively articulate (in)security. Similarly, the relationships between what is mobile and what remains immobile is for Dijstelbloem productive of a nuanced and refined understanding of "climate migration", despite the shortcuts entailed by this formulation, which he attentively addresses.

I agree with Dijstelbloem that "climate migration" constitutes a slippery concept that nevertheless needs to be retained and investigated. This is true of policy discourse, where in the last two decades resistances to linking desertification with migration have revealed the vested

interests of nation states. The efforts the United Nations Convention to Combat Desertification (UNCCD) has put in foregrounding such nexus were not detached from a political mission. At the very least, talking of "climate migrants" allows opening up the narrative which is usually focused on the unrealistic concept of "economic migrant". It shows that not only poor people move, but also those hit by climate change. Although the two populations may overlap to a great extent, I suggest that the two diverse framings involve different distributions of responsibilities: while poverty in many cultures may be imputed to individuals, climate change is by definition a phenomenon to be attributed to collective choices.

And yet the concept of "climate migration" has value not only at the policy level, but also as an analytical lens and theoretical formulation, as I will try to argue in what follows. I see three reasons why climate migration can constitute a key object of study (and provocation) for the STS community. First, it revitalizes one of the original concerns of STS: the multiplicity of relationships, which cannot be reduced to direct causality. Second, given its capability to show that nation states have not lived up to their responsibilities, climate migration constitutes a powerful evidence of denationalization and questions the modern contract between science and society. Third, immobility in climate migration can be framed in a novel light by interrogating the STS notion of inertia.

First, as Dijstelbloem suggests, composite terms imply a relationship which is usually assumed to be causal. When it comes to climate migration, climate change is supposed to trigger mobility. I suggest that it is exactly this direct, deterministic relationship, this short chain of action that produces the collective anxiety about climate migration that Dijstelbloem describes in his contribution: an input (climate change) will without fail produce a well-defined output (mass migration). Hence the securitization of climate change, that can be conceived of as an anxious reaction to a deterministic relationship. To avoid the short-cuts of determinism Dijstelbloem resorts to multi-factoriality, which is indeed one way to escape direct causality. As he suggests, "climate change is not an independent driver but part of an assemblage of life circumstances, development, environmental conditions, state governance, and international relations".

While I agree with this interpretation, I would like to suggest a further way out of determinism, drawn from the STS toolkit: focusing on the specificities of the mediators. It is necessary to unpack both the black boxes of "climate change" and "migration" to follow the minute details of how their relationship is built, the mediators that come into the equation, and the multiple directions in which the relationship could unfold. How do mediators like infrastructures, regulations, family networks, expectations, media discourses, colonial imaginaries, period of life intervene in the meaning given to climate change, as well as in the decision to move or to stay? Do they support, facilitate or discourage and hamper mobility? Asking these questions would facilitate to avoid determinism – and the related anxiety – by acknowledging the multiple, invisible, more-than-human forms of agencies mediating the relationship between climate and migration.

The second reason why climate migration can open new fields of inquiry for the STS community has to do with responsibility. Dijstelbloem discusses climate migration as a field of study, a repertoire of technologies and a space for international political action. All these three aspects hold together: climate migration entails new methods to produce knowledge about an emerging phenomenon, new technologies to deal with it, and new alliances between global actors. At the same time, this speaks for a novel relationship between climate migration and responsibility. Who and what is to be held responsible for climate migration, how are they ex-

pected to deploy technologies, and towards which desirable new future alliances? Dijstelbloem provides a scant hint in this direction when he writes that "if there was an intended monopoly by the nation state, climate change puts pressure on the right to control people's movements from all sides". He seems to suggest that nation states' monopoly in controlling mobility could be jeopardized by their lack of responsibility in curbing climate change.

Even more explicitly, I suggest that climate change shows that states cannot morally claim a monopoly of mobility over territory because they have not been able to assure livable conditions in those same territories. They were expected to be responsible for territories according to the modern contract (Mukerji 2011; Sassen 2006), and yet have not been. Therefore, they could be seen as having lost monopoly over mobility to, in and across those territories. Climate change, in other words, by showing that Hobbes' king is naked, constitutes a powerful evidence of denationalization.

More precisely, climate change is evidence of denationalization because it questions the modern contract between nation-states, human beings, science and capital. We know that such IXX century contract was grounded on colonial and homeland exploitation of nature. This contract was in turn based on the XVII century epistemological division of labor between politics and science, with the first in charge of moral, economics, rhetorics and religion, and the second in charge of nature, machines, engines (Rip 2014). In both cases, science and technology were free to experiment insofar as their outcomes could contribute to advance the progress of society, and did not mingle with politics and religion. It is also important noting that in this division of labor, in this contract, nature was not included as an active agent, but silenced as mere reservoir of value.

Now, climate change is showing that this contract is shaking, as nation states have not lived up to their responsibilities over territory. Of course, they were not alone, and science and capital have made their part, but still nation states were the ones constitutionally responsible for the livability of their territories (Sassen 2006). On top of that, nature is pressing to be emancipated from its role of mere reservoir of value and be included in the contract. And yet in STS we know that adding a part to a contract is not a painless process. If a further agent is involved, the whole network, in this case the whole contract, must be renegotiated. This includes a renegotiation of the identity, roles and responsibilities of the other actors already involved. If states have not been responsible towards their territories and nature pushes to enter the contract, then also the roles, responsibilities and identities of society, capital and science have to be renegotiated.

This is where mobility kicks-in: if nature presses to be included and humans and non-humans are not bounded anymore to the modern contract – if they feel they have been betrayed by irresponsible states who failed to assure livable conditions in their territories, then they feel they have a right to establish other types of contracts. We have seen it with viruses and the recent pandemic. We see it with mobility and climate migration: people are seeking contracts with other, more suitable assemblages. Then the question is: who and what is signing new contracts with whom? On the basis of which living needs? Is any regulation possible – any new contract redistributing roles and responsibilities, and in case, on the basis of which criteria?

While there is no easy answer to these questions, an observation is possible. Accounts of climate mobility often resort to asymmetrical narratives. Viruses jump from one host to another. Humans are seen as individuals longing to reach a new state, a new polity, a new society. In both

cases, accounts are asymmetrical in that they oppose mobile individuals (i.e., the threatening guests) to immobile collective entities (i.e., the vulnerable hosts). Dijstelbloem lecture is insightful in that it problematizes this asymmetry and all too easy semi-symbolism between mobility as a threat and immobility as vulnerability. His argument that we need a more conceptually refined understanding between mobility and immobility to deal with the challenges of climate migration in this light is to the point. Schewel's proposal of four categories of mobility/immobility, including voluntary immobility and acquiescent immobility, is to be appreciated, as well.

This appreciation eventually leads to the third reason why STS might enter a dialogue with the ambivalent concept of climate migration. I suggest that STS can offer a strategic concept to pursue the refinement of immobility: the concept of inertia. That we should not fully overlap the onto-epistemic dimension of becoming with the spatial dimension of mobility becomes clear once we take inertia into account. In STS, inertia cannot be taken for granted. Assemblages, social actors, organizations are not endowed with some inertia, but need to be constantly kept up by group-making efforts. If they are not performed, they stop existing. Inertia, durability, stability, obduracy can only be explained by appealing to technologies, artefacts, infrastructures that crystallize change into material-semiotic assemblages.

In this view, both the mobile and the immobile can be considered as outcomes of efforts to counteract inertia. Immobility too requires the expensive deployment of means to keep things immobile, to counter the decay that would come with lack of action. Consequently, the question about immobility transcends the semi-symbolism between a threatening mobility and a vulnerable immobility. The questions about immobility concern how people can organize their immobility; at what costs; through which means; how those costs can be compared to the costs and means of mobility. Dijstelbloem seems to imply something along these lines when he states that "it is interesting to see [...] what specific configuration of mobility and immobility is developed in the research field" of climate migration. Studying such configuration through the STS notion of inertia could help to make further novel steps in the foundational discussion between contingency and stability. Eventually, STS could even contribute to the study of immobility through its performative approach.

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Drawing Bruno Together

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Abstract
This *Crossing Boundaries* stems from two events: the recent STS-Italia conference (Bologna, June 2023) and the 4S/ESOCITE conference (Cholula, December 2022). Both events dedicated a space for reflecting on Bruno Latour's intellectual legacy, inviting some of the scholars who had the chance and the privilege to work with him. The text opens with a reflection by Madeleine Akrich on her two-decade experience working alongside Latour and on the multifaceted nature of his contributions to sociology, anthropology, and philosophy. The text continues with a contribution by Huub Dijstelbloem, who explores Latour's magmatic thinking, emphasizing the transformative power of his ideas. Annalisa Pelizza traces two key associations in Bruno Latour's intellectual trajectory. The first one traces back to Latour's early engagement with the semiotics of the "École de Paris" and Greimas' theory of enunciation, emphasizing the local context of the French semiotic debate. The second association delves into Latour's connection with technofeminism and Donna Haraway's material-semiotics, highlighting a global dialogue initiated in the late 1980s. Finally, Paolo Landri underlines the transformative potential of Latour's vocabulary in the context of education, underlying the interdisciplinary connections fostered by following Latour.

Keywords
Latour; sociology; anthropology; material-semiotics; education.

The many facets of Bruno Latour

Madeleine Akrich

I had the privilege of working in the same research center as Bruno Latour for about 20 years. When it comes to looking back on what he brought us, this is also a disadvantage. This

proximity blurs points of reference, dilutes the events in the continuous fabric of a shared daily life, and ultimately raises doubts: who was he, a sociologist, an anthropologist of science and technology, a philosopher, to use some of the labels he gave himself? Likewise, the subsequent evolution of his work questions about his project in retrospect: was his work on science, then on technology, only a first step, conceptualized as such from the outset, or has it become so as he traced his intellectual path, site after site, book after book?

My first contact with Bruno Latour took place during my final year at the École des Mines, when I decided to specialize in sociology. I had to draft a small research project, and wanted to work on the restoration of works of art. He gave me access to a fascinating case, the *Beaune polyptych*, because members of the Latour family had been on the board of the Hospices de Beaune and thus involved in the last restoration of the polyptych in the seventies. I went to Beaune, and was welcomed by his mother in the family home, one of the many examples of the hospitality of Latour and his family. I interviewed his uncle who guided me in the Hospices de Beaune, in the monument as well as in the institution. I had a glimpse of what he himself described as a bourgeois Catholic provincial family and the confidence it gave him: he never had any doubts about his place, even if the choice of an academic career was certainly not the most expected in his family.

A few months later, after graduating as an engineer, I joined the *Centre de Sociologie de l'Innovation* (CSI) to work on a research contract on energy technologies in developing countries. This may seem very strange, because I had no training in the social sciences, other than three basic courses and a dissertation, but back then, a lot of things were possible.

And this idea that many things were possible could be applied to the next ten years at the CSI. First of all, with the exception of Lucien Karpik who had been the first director of the CSI, all CSI members were under 40 years old. Michel Callon and Bruno Latour had a pioneering spirit; they shared very high ambitions, perhaps not exactly the same, but at least they both wanted to be part or even be amongst the leaders of this new STS field.

Surprisingly, like all CSI members, I only recently discovered how Callon and Latour's relationship had developed: in a long paper Callon recently published (2023a), he provides a very interesting and moving testimony on their collaboration. Their first contacts resembled an intellectual romance. They met for the first time in 1978 at Latour's initiative:

> After a few minutes, we agreed on the program to be put in place: to enter the black box of scientific practices and focus on the only thing that matters: their content. [...] Latour's visit was most welcome. He brought with him a breath of fresh air from the Anglo-Saxon world. (Callon 2023a)

After this first contact, many others took place, including regular lunches in a brasserie in the Odéon district with Latour, Callon and the philosopher Michel Serres, where I suppose they remade the world, at least the world of science and technology studies.

Four years after their first encounter, Callon managed to secure a position for Latour at the École des Mines, and so began an intense decade of collective work between these two outstanding researchers.

The intellectual momentum Callon and Latour had created through their near-secret encounters generated an extremely stimulating atmosphere: the world of possibilities seemed completely open to us. Neither did we care about academic positioning within the French

microcosm, as evidenced by the fact that temporary and permanent members of the CSI came from a wide variety of backgrounds, engineering, history, business schools, development studies, urban planning, etc., almost everything except sociology!

The prior exchanges between Latour and Callon had made it possible to build a collective project based on the solid foundations provided by each of them: inscription and actant for Latour, translation for Callon, and then notions developed jointly such as that of spokesperson (*porte-parole*). Far from being restrictive hypotheses, all these notions appeared to us as descriptive tools allowing us to explore in new ways the making of scientific facts, technologies and beyond. We were very surprised to be perceived from the outside as a kind of sect, rigidly dogmatic, while from the inside, we had a feeling of great freedom and openness, manifested itself through the variety of research topics and the liveliness of our discussions.

The general atmosphere was very joyful and collaborative. Every seminar was fascinating, owing to the brilliant ping pong between Callon and Latour, in which we all tried to participate: Antoine Hennion brought his particular touch to the table with his concept of mediation, forged in his work around music; even Karpik who was probably the only one not partaking into the CSI Callon-Latour project certainly played a useful role with his provocative remarks and questions that he punctuated with a laugh rivaling Bruno's famous one. As Callon wrote in the aforementioned article, Latour liked nothing more than being challenged on his texts before they were published: so even if Karpik and Latour were not very fond of each other, their skirmishes could be quite productive.

After about ten years of intense work together, things began to change. Not sure that any of us clearly understood what was at stake. Callon's article as well as the article by Antoine Hennion in the special issue of *Pragmata* devoted to Latour (Hennion 2023) give credence to the idea that the late Latour, the one from *An Inquiry into Modes of Existence*, had always been there. Latour himself accredited this idea in a paper he wrote on the genesis of the Inquiry (Latour 2013). But the very fact that they all need to make this point may also suggest that it was not so clear. As Hennion put it, Latour "realized" this project, in the double meaning of the verb "réaliser" in French: making something real and becoming aware of something. The first time he presented his "regimes of enunciation", which later became his "modes of existence", nobody really understood what he wanted to do.

It also marked a break in his relationships with the CSI collective. Up to that point, I believe we had all been working together, developing our own analyses, borrowing from others and vice-versa. From then on, Bruno became preoccupied with his own work and was somewhat frustrated by CSI's lack of enthusiasm for filling in the many boxes of his model, which ironically illustrates the limitations of the CSI – sect model. He was also looking for deserved recognition for his work, and while the École des Mines was a place of great academic freedom, it was not really a place where one could hope for such recognition as a philosopher or a sociologist.

Latour's contribution to the life of the CSI and beyond has been immense. If I try to characterize the specificity of this contribution, I would say that there are four facets of his personality that were decisive: Latour was a philosopher, a writer, a creative thinker – and a teacher, and it was the constant intermingling of these four aspects that produced the most innovative effects. None of this would have been possible without the tremendous vital energy that inhabited him, pushing him ever further into the exploration of the possible.

That he is a philosopher may seem obvious today. It was less so during his time at CSI: he often had trouble introducing himself, and would use the label of sociologist or anthropologist, but always half-heartedly. This wasn't a problem for the CSI, since we didn't need a well-defined disciplinary affiliation. In a recent presentation, Callon (2023b) develops the idea that Latour, who chose to practice "field philosophy" or empirical philosophy, had long considered himself an amateur philosopher, and that he was only able to assume the status of philosopher when he was convinced by the confrontation to certain philosophical books and philosophers, such as Isabelle Stengers, that he was indeed a professional philosopher.

In retrospect, it seems to me that this identity as a philosopher, as vague as it may have seemed, played an important role in his way of being and acting, and had an impact on the collective that we formed. One notable feature was his ability to detect researchers from any disciplinary background to discuss with and his capacity to formulate questions making a dialogue possible. He brought a whole intellectual world to the CSI – when he joined the CSI, he had already quite an extensive international network from which we benefited. He was also so self-confident that he could persuade anyone to come and discuss with him and us: anthropologists, historians, art historians, ethologists, prehistorians, researchers in management science, mathematicians and so on.

His vocation as a teacher was palpable in the passion he put in supervising the CSI doctoral students, as well as in his work teaching students at the École des Mines and later at Sciences Po Paris. But what undoubtedly sets him apart is his tireless drive to innovate in this area, somehow stemming from a cross-fertilization between the teacher and the creative thinker. Rather than transmitting unchanging knowledge, his aim was to lead students towards new experiences. As he used to tell his doctoral students, writing is the work by which thought emerges, and it's a work that requires practice: just as he spent his days blackening his notebooks with illegible fly-paws – he was doing his scales, he used to say – he encouraged students to practice by proposing all kinds of exercises. It was this same determination to develop new forms of teaching that led him to launch a major pedagogical program, *FORCCAST*, dedicated to exploring contemporary controversies – in a variety of pedagogical forms, from dossiers to websites, theatrical performances and simulations – which has become a flagship exercise from high school to many higher education sites in France and abroad.

I have just given a few examples in the field of pedagogy, but creativity was Latour's way of being: each time, he imagined innovative ways of bringing together fields or forms of action that were usually separate. He seemed to find some sort of youthful jubilation in this kind of experimentation. He devised theatrical forms for academic events, proposed a highly unusual book format with *Paris Ville Invisible*, embarked on the organization of exhibitions, conceived *An Inquiry into Modes of Existence* as both a classic book and a collective web platform, wrote plays, set up a master's degree in experimental political arts etc. He was a daring man, and no form of experimentation frightened him.

His ethos as a philosopher, his vocation as a teacher, his creativity – all these elements of his personality are reflected in his writings. Because he never ceased experimenting in his books with a variety of forms of writing according to each intellectual project, and was never content to mold himself into the conventional formats of academic writing, I think he can also be considered as a writer.

The first aspect that stands out is the number and variety of his productions. Many of his

early books are based on a "field work" or an archive work he carried out: *Laboratory Life*, *The Pasteurization of France*, *The Making of Law – An Ethnography of the Conseil d'Etat*, *Aramis or the Love of Technology* are examples for this. However, even if very empirical, these books are also deeply analytical in their organization. After a while, he began to write books where the argument was clearly the organizing principle, where the idea is somehow to propose a way of describing and seeing that shifts our perception of the world we live in, of modernity and of the role of science in our societies. *Science in action*, *We have never been modern*, *On the Modern Cult of the Factish Gods*, belong to this series which culminates in the *Inquiry into Modes of Existence*, a book that fully assumes its status as a philosophical work. More recently, he wrote a whole series of books aimed at the educated general public in order to raise awareness on the ecological crisis and again to shift our perception of what it is to inhabit the Earth.

But this simple classification should not obscure the fact that each book has its own particular physiognomy, linked to the author's search for an adequate form to convey the underlying project. The intention of many of his books is to share an experience with the reader: not to show an external reality, but to embark the reader on a journey that is both intellectual and sensitive, at the same time producing a way of apprehending the outside world.

The reader is constantly present as a central figure in his writing, in a variety of ways: in some cases as in *Aramis*, s/he is personified in a narrative by a fictional being whose fluid contours enable the author-investigator to communicate with a reader-investigator. In other cases, the reader is directly addressed by a "you" spoken by the author's "I", and engaged in an imagined dialogue. Elsewhere, the use of "on" – this strange French pronoun that can be indefinite or personal, designate an individual or human beings in their generality, include or exclude the speaker – leaves the reader free to choose his or her position, and even allows him or her to slide from one position to another. A more in-depth political-semiotic analysis of the use of pronouns in Latour's books would undoubtedly be necessary, and would shed light on the way in which his philosophical background, his vocation as a teacher and his creativity were in some way linked in the writing formats he has adopted.

In any case, Latour's formal work was intended to make his books accessible to a wider audience than that of his peers; he was always in search of a form of argumentative clarity: beyond his intellectual contributions, it seems to me that he is inviting STS to (re)make this concern for the reader – which can of course take other forms – their own.

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Magma for the Mind

Huub Dijstelbloem

1. Discovering Latour

Magma. If there is one word that expresses how Latour's work entered my life and affected my thoughts, reshuffled them, and changed my worldview, it must be this term. As Tommaso Venturini (2009) explains in *Diving in magma: How to explore controversies with actor-network theory*:

> As the rock in magma, the social in controversies is both liquid and solid at the same time. But there's more to this metaphor: in magma solid and liquid states exist in a ceaseless mutual transformation; while, at the margins of the flow, the lava cools down and crystallizes, some other solid rock touched by the heat of the flow melts and becomes part of the stream. The same fluctuation between different states of solidity can be observed in controversies. Through this dynamic the social is unremittingly constructed, deconstructed and reconstructed. This is the social in action and that's why we have no other choice than diving in magma. (Venturini 2009, 258)

The mutual interaction and transformation of magma and rocks resembles the famous description of Deleuze and Guattari (1987) on the orchid and the wasp in *A Thousand Plateaus*. According to them:

> The orchid deterritorializes by forming an image, a tracing of a wasp; but the wasp reterritorializes on that image. The wasp is nevertheless deterritorialized, becoming a piece in the orchid's reproductive apparatus. But it reterritorializes the orchid by transporting its pollen. Wasp and orchid, as heterogeneous elements, form a rhizome. (Deleuze and Guattari 1987, 10)

It will come as no surprise that Latour was sympathetic to the suggestion to rename actor-network theory as actant-rhizome ontology (Latour 1999, 19). The magma metaphor is significant in many ways, one of which is that it foreshadows Latour's later interest in questions of climate, earth, and critical zones. As I will explain in more detail later, Latour's magmatic thinking was not without complications. But if we follow the magma metaphor for now, to me discovering Latour was like jumping into a volcano and being overwhelmed by the magma under the surface of the earth. Everything that I thought was solid and certain melted. Meanwhile, I had the feeling my most daring, fluid, adventurous, speculative, and amorphous thoughts solidified and took shape.

When the Dutch newspaper *De Volkskrant* interviewed me in 2016 about what motivates me in my research, the headline read, "It still helps when I ask myself: what would Latour do?" That holds still true. In the interview I explained that in the early nineties I was fed up with studying philosophy. I had all kinds of jobs, as a film critic, as a radio talk-show guest, even as a band manager. But what brought me back to my studies was the discovery of Sci-

ence and Technology Studies, STS. The relationship between the Dutch STS community and international STS has always been very productive, as has the relationship between Latour and Dutch scholars. Since the 1980s, there have been close contacts and annual meetings between the Netherlands Graduate Research School of Science, Technology, and Modern Culture (WTMC) and the Center for the Sociology of Innovation (CSI) at the École Nationale Supérieure des Mines de Paris (ENSMP), and scholars such as Wiebe Bijker, Annemarie Mol, and Gerard de Vries, and later Noortje Marres and Peter-Paul Verbeek have promoted the development of STS in the Netherlands and exchanges with Latour and his colleagues. When asked about the fertile ground that the Dutch delta seems to offer for this kind of research, Latour once remarked that this should not come as a surprise, since the whole of the Netherlands, with its dikes and water boards, is socially constructed.

I took a course in science journalism at the University of Amsterdam's STS department. One day a teacher showed a video, he must have recorded it himself from television, a broadcast of the VPRO program *Noorderlicht* about the French philosopher Bruno Latour. It knocked my socks off. Latour was being interviewed at the Musée de Minéralogie, explaining that a crystal in a museum has hardly anything to do with nature. I thought it was phenomenal, and I still think it is, perhaps even more so today. The immediate effect of that one videotape was: I must study under his supervision. I took part in the Erasmus exchange program and enrolled at the École des Mines. But would they let me in? E-mail was just beginning to be used among students, so instead of writing him, I decided to take the train to Paris. I went to the reception of the École des Mines to ask for an appointment. But because of my terrible French, the receptionist thought I had an appointment with him. While I was waiting, Latour, two meters tall and impressive, suddenly approached me: "Did we have an appointment?" No, we did not, but he listened to me and said: "Send me a proposal". Half a year later I was able to go there for six months on an Erasmus scholarship.

My time there coincided with the so-called "science wars": the heated discussion about the presumed relativism of Science and Technology Studies fueled by the publication of Alan Sokal's (1996) hoax in *Social Text* and David Bloor's (1999) attack on Latour's program with an article titled "Anti-Latour". Sokal, a physicist, had written a nonsensical article based on supposed parallels between physics and postmodern thought, and peppered it with quotes from famous postmodern authors. By publishing his hoax, and passing the peer review exam, Sokal aimed to demonstrate that the quality standards of academic journals, which welcome publications in the postmodernist genre, do not meet the requirements of academic rigor. He also accused Latour of being complicit in relativism – and, according to Latour, of being French – by being unclear about his ontological and epistemological claims. The bottle of wine from the family estate that Latour later handed to Sokal to open the peace negotiations that could end the Science Wars was not subjected to a reality check by the physicist, afraid as he was of being poisoned. Independently of this, David Bloor, a sociologist of science, also accused Latour of going a step too far. It was not the first struggle between STS and the Sociology of Scientific Knowledge, SSK. The so-called Strong Program, advocated by Bloor and others, argued that both historically proven "true" and "false" scientific theories should be treated in the same way to understand their significance. This premise was christened the "principle of symmetry". In *One More Turn after the Social Turn: Easing Science Studies into*

the Non-Modern World, Latour (1992) argued that this principle should be extended because it was still captured by a modernist bias and a modernist distinction between subjects and objects. Therefore, Latour introduced a generalized principle of symmetry that should apply equally to humans and nonhumans. According to Bloor, this generalized principle was a bridge too far. By attacking this flattened ontology, he undermined virtually the entire methodological program of the Centre de Sociologie de l'Innovation. "The ship of CSI is sinking" Latour declared with much irony when his response to Bloor was discussed in a meeting. As we all know: instead of sinking to the bottom of the sea, the ship traveled around the world. Moreover, in the following decades, marked by a growing awareness of global warming and an intensification of the relationships between people, technology and knowledge, such as artificial intelligence, the world became more and more Latourian.

2. Working with Latour's work

Interpreters of Latour are already grappling with the inevitable intellectual-historical question of whether there is a strong continuity in his work or whether there are certain breaks in the development of his *oeuvre*. On the one hand, if we stick to his books, it can be argued that his work developed out of a strong engagement with science and technology studies in *Laboratory Life* (1979, with Steve Woolgar), *Science in Action* (1987), *The Pasteurization of France* (1993a) and *Aramis, or the Love of Technology* (1996) to a broader political theory perspective in *We Have Never been Modern* (1993b), *Politics of Nature* (2004) and the catalogue of the exhibition with the same name *Making Things Public: Atmospheres of Democracy* (2005, with Peter Weibel) to a philosophy of Gaia, the climate regime and the politics of the earth exemplified with *Facing Gaia: Eight Lectures on the New Climate Regime* (2017), *Down to Earth: Politics in the New Climate Regime* (2018) and the volume, again with Peter Weibel, *Critical Zones: The Science and Politics of Landing on Earth* (2020). This development coincided with his rising fame and the increased interest of scholars from other disciplines. On the other hand, it is undeniable that Latour's ontological interest shows a strong continuity and that there is a soft but steady building, strengthening, deepening, and broadening in his work from part two of *The Pasteurization of France* (1993a), "Irreductions", to *An Inquiry into Modes of Existence* (2013). At first glance, it might seem that there is a tension between descriptions in terms of networks, which relate everything to everything else and cut across different social, technical and political domains, and modes of existence, which seem to imply distinguished spheres. What these approaches have in common is a focus on becoming, on the emergent features of associations through which networks give rise to particular modes of being. As such, networks can crystallize in specific forms, shapes, modes. Notwithstanding this continuity, the intensity of global warming and climate change, and the harshness of global inequality, have left an unmistakable mark on his later work.

In my own work, I have tried to combine science and technology studies with political theory, philosophy of technology, and philosophy of science. Since I am interested in how states, power, knowledge, and technology develop and interact, I found an interesting field of research in the overlapping disciplines of international relations, security studies, and border

and migration studies. The question of what borders are and how they are created proved to be a very productive one, linking questions of state formation, sovereignty, and citizenship with research on infrastructure, geography, politics, mobility, and security.

I have used Latour's work I think in almost all my publications, but most profoundly in the book *Borders as Infrastructure* (2021). In that book I aimed to develop a morphological approach to understand borders. This approach means I attend to the shape of concepts and ideas, the form they take, technically and materially, when they are made to travel and connect. Meanwhile, I elaborate on Latour's analysis of tensions and frictions, the way connections between humans and nonhumans, between politics, technology and knowledge and nature are made and unmade. Drawing on Boltanski's and Thévenot's *On Justification* (2006), I introduced the concept of "infrastructural compromises" to explain the combinations of different technopolitical regimes, such as economic and ecological considerations in the development of wildlife crossings or, in this specific field, the development of "humanitarian borders" in which security and humanitarian imperatives are combined.

Attending to the study of borders also implies a methodological perspective and this is where the idea of magma returns. Rather than focusing on the two outer poles, two or more countries in this case, and on how a border cuts through them, demarcates and divides them, I want to start "in medias res", seeing borders as entities that generate territories and categories, such as those who can and cannot enter a state. In this sense, I understand borders as a boundary concept, but in a very material and morphological way. Like magma, they have an effect on what encounters them, and they are transformed as a result of all the traffic that does and does not take place. Meanwhile, as I developed this perspective by working closely with colleagues in international relations, migration, and security studies, with whom I shared the goal of advancing STS concepts and approaches, I realized that the relationship between ontology and political theory should be made more explicit. The violence as expressed in Europe's border politics, the geopolitical positioning of the EU, and the colonial roots of many international infrastructures require a more intense engagement with political theory. But what kind of political theory?

3. Latour and Europe: everything may be allied to everything else

Working with Latour's theories means trying to understand his thoughts, making them your own, applying them, modifying them, and at a certain point also questioning them. These questions concern in particular Latour's discussion of "Europe". I think this discussion is instructive, because it shows how Latours thinking can develop in interesting ways and inspire scholars in different field – international relations, political theory, geography, migration studies, security studies. Witness the impact he had on the work of Andrew Barry (2001), Marieke de Goede (2018), Timothy Mitchell (2011), Mark Salter (2015; 2016) and William Walters (2016; 2017), and on historians of technology interested in international relations such as Paul Edwards (2013) and Gabrielle Hecht (2011) – and vice versa. It is also instructive because of the manifest complications: when it comes to Europe and his discussion of geopolitics, Latour's work was still "under construction", looking for its ultimate direction.

Latour tried to unravel the relationship between the earth, territory, sovereignty, and ju-

risdiction and to re-imagine Europe in a time of climate change. Judging him by his own standards, I think it took him a while to find the right settlement. It is of course impossible to summarize Latour's philosophy in one sentence, but if there is one motto that captures most of his work, I think it is this one from *Irreductions*:

> Nothing can be reduced to anything else, nothing can be deduced from anything else, everything may be allied to everything else. (Latour 1993a, 163)

In the case of "Europe", he struggled with this (see Latour 2020; 2021; 2022). He aimed at connecting a geological political philosophy interested in the earth, the soil, the terrain, and the resources below the surface to a geographical political theory engaged with authority, power, territory, and borders. That is an intriguing thought. The idea behind the creation of the European Coal and Steel Community (ECSC) after World War II in 1951 was that if we link the resources and raw materials that are underground – coal and steel – to the political order that connects above ground – sovereign but highly dependent nation-states – a lasting peace might emerge or at least an immediate eruption of intense conflict could be avoided. French Foreign Minister and long-term builder of post-war Europe Robert Schuman once declared he aimed to "make war not only unthinkable but materially impossible". What France and Germany had failed to achieve several times above ground had to be established by a route underground. The ECSC became a blueprint for the supranational and institutional structure of the European Community and the later European Union.

The basic idea that there is a relationship between the political economy of raw materials, resources and commodities, on the one hand, and the development of political systems and state forms, on the other, is fundamental in Timothy Mitchell's work, especially his *Carbon Democracy* (2011). Mitchell shows that the monopolistic power relationship over oil, wells and refineries in the Arab world and the Middle East produces a certain technological and economic infrastructure that relates extremely poorly to democracy and is better suited to autocratic and authoritarian regimes. That line of thinking was inspired by Latour's methodological principle of symmetry between politics and technology and, conversely, inspired Latour's thinking on international relations. At the same time, Latour never delved into international relations, political economy, and the world of commodities or the infrastructural history of Europe as much as he did into the Salk laboratory, the scientist Louis Pasteur, the transport system Aramis, or the infrastructure of Paris.

So how did Latour try to – using his own terminology – unscrew the big European Leviathan? When he discussed a possible European constitution or considered Europe's geopolitical role, one of the complications of Latour's analysis is that he does not seem to make a distinction – or deliberately refused to do so – between Europe as a continent and Europe as a political entity. On the one hand he studied the relation between sovereignty, jurisdiction, and territory by exploring the works of the conservative and controversial thinker Carl Schmitt (Latour 2021) and political philosopher Eric Voegelin (Latour 2017, *Lecture Six*). On the other hand, he aimed at exploring Europe's position confronted with the climate regime, international migration, and nationalist and populist threats. In a Guest Editorial for the *Common Market Law Review* entitled "Europe is a soil – not a machine", Latour (2020) wrote:

> Fortunately, Europe as a thing, as a material reality, as a soil, possesses the right size and the right history for this landing, away from the two abstractions of globalization, on the one hand, and a return to the imaginary protection of isolated nation States, on the other. If so many people dream of their Heimat, it might be a good moment to reclaim Europe as our Heimat. (Latour 2020, 2-3)

And in "Is Europe's soil changing beneath our feet?" from 2022 he wrote:

> I am interested in Europe not only as an institution, but also as Europe as a territory, as a soil, as a turf, as a land, or, to borrow the German expression, as *Heimat*, with all the difficulties of that term. (Latour 2022)

Soil, Heimat, land? What happened to "Nothing can be reduced to anything else, nothing can be deduced from anything else, everything may be allied to everything else"? Although Latour was of course far too knowledgeable to use these words in a naïve sense, and redefined them to suit his purposes, he nevertheless made firm but also controversial statements about Europe. He had to navigate between the Scylla of land-related politics and the Charybdis of a Eurocentric worldview. But he found a way out, or, to put it less disrespectfully, he created the famous Latourian middle position again. Latour explained he was interested in questions of "attachment" and aimed to explore notions of land, to see "Europe as a thing, as a material reality" (2020, 2). In his last book *On the Emergence of an Ecological Class: A Memo* (2022), written together with Nikolaj Schultz, in one of the lemmas Europe pops up again. He describes Europe as a "kind of experimentation", a test lab – a "thing" – that relates the inside to the outside. With the notion of "Thing" he returns to the etymology explained in *Making Things Public* (2005), in which a "Ding" is not just a material object that is politicized, but an issue, a matter of concern that becomes a matter of politics and gathers an emergent public that is not confined to state borders or sociological classifications. In this way, he links the physical and geographical properties of Europe as land with the political issues of inclusion and exclusion, and of attachment in times of climate change. Finally, Europe seems to have landed. Not on land, it seems, but in the overarching atmosphere of the climate regime. In the end, he did arrive at the conclusion that no soil can show us the way. Just as Latour made his theory about the new climate regime and about Gaia "land" with the notion of the "critical zone", in the end Latour found a way to express his attachment to Europe with a less historically affected notion than Heimat and soil. At the end of the day, Latour replaces one discussion with another and renders the initial debate obsolete by introducing his own conceptualization of an issue. And that, in a nutshell, is the main didactic lesson I hope to take from Latour.

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Geo-politics of the Global- and Local-plus: Latour's Associations with Semiotics and Technofeminism[1]

Annalisa Pelizza

1. Introduction

> There, I've finished. Now, if you wish, it's your turn to present yourself, tell us a little about where you would like to land and with whom you agree to share a dwelling place. (Latour 2018)

Since the passing away of Bruno Latour in October 2022, several contributions in memoriam have tried to recall personal memories, academic events, lines of thought and the provocative style that characterized his writings. In no way is this contribution different in its effort to address the dilemma of choosing some aspects of Latour's work. And yet it might set itself apart thanks to its focus on two aspects – he would say "associations" – that might not be the most representative, but the most geo-politically (the dash makes all the difference, as Latour taught us) antithetical: one is local, the other one has marked the global development of our discipline. Taken together, they constitute my answer to the invitation in the quotation above.

The first association, with the semiotics of the "École de Paris" and Greimas' theory of enunciation, goes back to Latour's early writings in the late 1970s and 1980s. It is local in that it flourished in the neighboring context of the French semiotic debate of those years, characterized by a reflection on textuality and enunciation as the act mediating between an abstract linguistic system (*langue*) and discursive acts of actualization (*parole*). The second association, with technofeminism and especially Donna Haraway's material-semiotics, reveals a dialogue across the Atlantic initiated in the late 1980s. It is global in that Haraway and Latour drew on different philosophical genealogies, political goals and citation cultures. Reaching overlapping concerns and akin theorizations in the 1990s and 2000s required to align several movements of translation. While this short contribution does not aim to reconstruct the whole alignment process, it stresses the key role of textuality in the process.

Before proceeding, a caveat. In no way do the expressions "local" and "global" imply a transition from provincialism to globalism, as if the association with French semiotics linearly

evolved into more international associations. Leaving alone the truism that "North American" does not per se imply "global", these expressions rather follow Latour's own reflection on the end of modernization. After the *Inquiry Into Modes of Existence* (Latour 2013), Latour's oeuvres have tried to move the compass of the public discourse to overcome the local vs. global modernist dichotomy, to embrace the terrestrial. In *Down to Earth* (2018) he voiced the need to abandon the local vs. global binary distinction brough about by modernization and to urgently embrace a political trajectory that leads toward the Earth. He posited two specular understandings of the global and the local as "plus" and "minus". Just as globalization used to be "plus" – oriented to discovery, cosmopolitanism and standardization – and turned "minus" – characterized by insecurity, domination and extractivism, so the local-minus of return to the past, resurrected traditions and nostalgia could leave room to a sense of belonging and a hospital, open and inclusive dwelling place.

There is no doubt that the two associations discussed in this essay are both "plus". The first one is less internationally explored, anchored as it is on a debate that has struggled to reach English-speaking journals; and still, it explains much of Latour's peculiar "flat" ontology while expanding in several directions. The second association is more internationally renowned, having been accompanied by public debates and attempts at mutual recognition between to science studies stars, and having marked important moments of alignment for the STS community dispersed in different locales. Both have constituted associations in which mediators have far exceeded intermediaries: the outcome could not be predicted from the input. As a result of these associations, STS have hit the ground in new territories, entanglements and overtures. What follows tries to briefly describe the two associations, and their ongoing implications for the STS field.

In line with STS's attention to multiplicity, this essay resorts to texts, conference proceedings, and conversations with witnesses, as well as to personal memories of encounters with Latour. While such a movement of subjectification is not usually apt to the folds of a scientific journals, the readers will hopefully exert mercy in the case of a short contribution written in memoriam of a scholar who has revealed the social nature of scientific objectivity[2].

2. Association #1: With semiotics and the theory of enunciation

I have encountered Bruno Latour when I was a PhD student at the University of Milan Bicocca. At that time, I was torn between an influent male supervisor in sociology and my background training in semiotics at the school of Umberto Eco. The classic earthenware among metal pots. In my distressed attempt to conduct a meaningful PhD research in the sociology of internet cultures using the semiotic analytical toolkit, I read a book that in the title claimed to be oriented to sociologists *and* at the same time moved arguments familiar to semioticians, such as that "the text is the social scientist's lab". With this expression, in *Reassembling the Social*, Bruno Latour (2005a) meant two things, in my early understanding. First, that testing the consistency of a text is a way for sociologists to assess the truth value of their research, as much as laboratory experiments assess the truth value of scientists' research. Second, that "texts" where not only those I had learned to analyze as part of my semiotic training. Texts were something broader.

Texts were the outcomes of enunciation (utterance, *énoncé*), but what if "enunciation" was to be understood in the broader meaning of enactment, practice, translation that brings something into existence? Then what is regarded as "text" could be made of many materialities. The empowering consequence for that torn PhD student was that, as she started thinking at enactments as "enunciation", then practices, artefacts, interfaces, databases suddenly appeared as potential "texts" she could link together in flat, heterogeneous networks. Thanks, Bruno, for having liberated that PhD student from the Scylla and Charybdis of semioticians and sociologists![3]

In other words, I had just discovered the semiotic roots of Bruno Latour's metaphysics. What he, together with Madeline Akrich, Michell Callon, John Law, Antoine Hennion and others named "translation", "delegation", "displacement" or "shifting" was in fact what Greimas' theory of enunciation called "*débrayage*": the jump from the I/here/now of the enunciation to a different subject/space/time of the utterance. With the major difference that in actor-network theory the jump could take place across different materialities. Years later, Maria Giulia Dondero would summarize my early discovery with a sharp expression: "a movement from uttered enunciation to practical enunciation" (Dondero 2018, 22, *my translation*). With this, she meant the shift from the discursive marks of enunciation (the I/here/now of the enunciator as simulacrum) to enunciation as an actualized interaction in presence, mediated by diverse materialities and artifacts.

It is this semiotic genealogy focused on the mechanisms of textuality that, I suggest, contributes to the exotism that is often attributed to Latour's writing style. John Searle once famously argued that Latour's "extreme social constructivist" position was seriously flawed on several points, and had inadvertently comical results (Searle 2009). This alleged comicality can only be understood in light of a theory of practical enunciation, where mediation can be exerted by anyone or anything endowed with agency.

Latour's intuition to export the mechanisms of textuality beyond text narrowly understood was crucial for STS, in that it allowed accounting for material affordances ("scripts" in Akrich and Latour 1992) without falling into technological determinism. This intuition was indebted to the above-mentioned difference between Latour's and Greimas' understanding of enunciation. While the latter postulated the "nesting" of the utterance in the act of enunciation, Latour borrowed a "flat" pragmatist ontology. As Dondero (2018) has pointed out, such a flat conceptualization of enunciation differs from Greimas' model, characterized by an "original rupture, a fall marking the passage between enunciation and utterance" (p. 38, *my translation*). Differently, as Paolucci (2020) has remarked, Latour's translation draws on Peirce's illimited semiosis made of chains of interpretants lying on the same ontological level. It is this flatness that allows following translation across different materialities. Or more precisely: every outcome of a step of translation can be deemed a text, be it materialized in an oral statement, a hotel key, a road bump, a car seatbelt, or a spreadsheet counting scallops.

Although usually overlooked, Latour's early association with semiotics and the theory of enunciation has steered STS' "rhetorical turn" after Kuhn (Sismondo 2010) in specific ways, constituting one of the field's multiple genealogies. An example is provided by two foundational STS conceptualizations like situatedness and multiplicity. The first concept was introduced by STS feminist authors like Haraway (1988) and Suchman (1987) to indicate the methodological and political need to avoid detached perspectives. The second concept

achieved wide recognition as one of the STS tenets with Annemarie Mol's "body multiple" (2002). As we will see below in the case of technofeminism, these authors had different genealogies than Latour's. And yet his attention to the mechanisms of textuality might have been crucial to ground his sensitivity on situatedness and multiplicity.

As Fontanille writing about Latour has pointed out:

> Enunciation does not know the generic singular: it is declined only in the specific singular, on a case-by-case basis, or, in general, in the plural. There are therefore as many existences as there are possible sendings, effective enunciations. (Fontanille 2017)

The comparison of the "specific singular", the case-by-case actualization prompted by enunciation with Haraway's and Suchman's call for situatedness is almost inevitable. STS' methodological humility might be indebted to feminist skepticism towards god's visions, but also, through a different genealogy, to the theory of enunciation. Similarly, the reference to the "many existences" enabled by multiple enunciations resounds with Annemarie Mol's multiple enactments of body parts and illnesses. For Latour, situatedness and multiplicity had an alternative genealogy in the theory of enunciation, and still these concepts feature among STS tenets. It was probably this genealogy that in *Reassembling the Social* brought him to state that: "semiotics does not survive sea travels. Attention to text qua text remains a continental obsession" (2005a, 122).

3. Association #2: With technofeminism and material-semiotics

This citation brings about the second association that for years has literally taken place across the Atlantic: the one with technofeminism and Donna Haraway's material-semiotics. While drawing on different philosophical genealogies, political goals and citation cultures, over the years this association came to address overlapping concerns about inter-species relations and akin theorizations about the need to move away from the representational paradigm. While it is not among the goals of this short contribution to map theoretical and methodological overlaps between the two scholars, I suggest that a common interest in the performative role of texts could have grounded this association by aligning several movements of translation.

Despite his association with textual mechanisms and the theory of enunciation, Latour was imprecise – or provocative – in stating that semiotics does not survive sea travels. The framing of "material-semiotics" was introduced in late 1980s by Donna Haraway and others in feminist STS to account for the enactment of objects and subjects of knowing. Latour's provocative remark might however go hand in hand with Haraway's claim of her distinct genealogy in women's science studies. As Haraway has clarified in an interview with Lykke, Markussen and Olesen in Aarhus:

> People like Susan Leigh Star, and Bruno Latour, and Andy Pickering, and I, and many others, we read each other. So, we end up being both deliberately and unconsciously in conversation. But this conversation and reading of each other's texts do not refer to a kind

> of shared origin story or genealogy. I have a very different genealogy in science studies than, say, Andy Pickering or Bruno Latour do. People like Susan Leigh Star and I share more of a genealogy in science studies that roots it, for example, in the women's health movement and in technoscientific issues, related to women's labor in the office or to Lucy Suchman's work. (Lykke, Markussen and Olesen 2000, 58)

This genealogical difference was accompanied by a different weight given to political issues, according to Haraway:

> The asymmetry is a historical, structural problem. It is almost impossible for folks in those locations [i.e., like Latour] to get it, and feminist technoscience work always feels like trouble, like "now you are getting political again". (Lykke, Markussen and Olesen 2000, 60)

For Latour, the political distance between them was more a matter of conflict and scale. In a 2005 chapter written for a book in homage of Donna but then rejected by the editor (Latour 2005b)[4], Latour staged a dialogue between the two of them at the margin of a conference. The dialogue aimed to figure out what divides them and what brings them closer. In Latour's own interpretation, what divides them is Haraway's need to see the big picture by adopting a post-Marxian critical approach, while Latour is depicted as a late Habermasian (by himself, note the self-irony!). On the other hand, what brings them close is the acknowledgement that science studies are in the middle of a difficult search for political relevance. They diverge on the methods (conflict and big picture on one side, assemblies and details on the other), but agree on the goal of changing irreversible power relations.

Whatever the interpretation, diversity in genealogies and political goals was reinforced by different citation cultures. Facing Latour's conservative citation style, Haraway used to point out an asymmetry in reciprocal acknowledgement:

> So after I was already doing, what I now call feminist techno-science studies, I read people like, for example, Bruno Latour. So Latour and other authors, which figure prominently in the canonized version of the history of STS, were not the origin in my story; they came after other events. And they do not get this! That there is a whole other serious genealogy of technoscience studies. So I remain irritated! (Laughter) Because we do know their genealogies, very well. And they do not know ours, even though they exist in writing. (Lykke, Markussen and Olesen 2000, 59)

Despite these distances, eventually Haraway's and Latour's works converged on a more-than-human, terrestrial, non-representational research agenda. A shared understanding in the performative agency of texts could have grounded this association. For Haraway, texts are never innocent, but performative, in a similar way as for Latour texts can act as litmus tests of truth value. In the same interview with Nina Lykke and others in Aarhus, Haraway recalls that texts are never only texts, but rhetorical devices and political tools (Lykke, Markussen and Olesen 2000). As a matter of fact, Haraway recurred to semiotics in the same period as Akrich and Latour (1992) formalized their semiotic genealogy. In her 1992 article *The Prom-*

ises of Monsters, she used the semiotic square as a sort of divertissement, in her own words "an artificial device that generates meanings very noisily" (Haraway 1992, 304). It was a serious joke, but it also shows the closeness of Haraway and Latour in taking the text seriously, acknowledging their performativity and addressing prejudices against texts as mere fiction.

In that same 2000 interview Haraway reclaims the performativity of her texts ("Writing does things", p. 53), that are nevertheless literary texts. While transgressing the boundaries between theory and literature is a long-term feminist practice, the same ambivalence of texts was advocated by Latour, according to whom texts are the outcome of translation across different materialities. Latour's imaginary dialogue with Haraway above mentioned (Latour 2005b) is in itself a literary and political text paying tribute to their association. The work of alignment of their contributions in the STS field – I suggest – may have well passed through a common interest in the mechanisms of textuality, and texts themselves!

Eventually, Haraway acknowledged that Latour took on some insights from technofeminism. Indeed, while traces of Latour's opening to technofeminism are scattered in his early works, they can be more systematically found since 1999, with the dedication of *Pandora's Hope* "To Shirley Strum, Donna Haraway, Steve Glickman, and their baboons, cyborgs, and hyenas". In the second move of *Reassembling the Social*, Latour even attributes to Haraway the most outspoken version of the multiple layering of enactment (Latour 2005a, 208, note 276), while mutual citations are recurrent from the 2000s.

4. To conclude: where would we like to land, and with whom?

The associations here discussed constitute two of the countless connections that Latour was able to establish during his intellectual trajectory. It's not my intention to claim they are the most representative, but to suggest that they somehow illustrate Latour's geo-politics, at the same time local and global. After the Inquiry Into Modes of Existence (Latour 2013), Latour's oeuvres have tried to move the compass of the public discourse to embrace the terrestrial. In Down to Earth (2018) he theorized two specular understandings of the global and the local as "plus" (i.e., both global and local can be open, welcoming, prone to create new associations beyond the modernist divide) and "minus" (i.e., both global and local can be insecure, nostalgic, anchored to modernist categorizations). As the citation opening this contribution makes explicit, with these specular understandings of the global and the local Latour invites us to open the black-box of modernists associations, look at what is inside, and start a new associating endeavor.

My selection of the two associations discussed in this contribution constitutes a first attempt to answer his invitation. Although it was local, the first association did not resolve into a nostalgic, purely inward-looking exercise, but revealed many further associations that contributed to weave what today we call STS. Similarly, the second association did not resolve into a global, standardized exercise, but revealed alternative, local and situated genealogies that over the years have contributed to build the STS field in its multiplicity. As a result of these associations, STS have hit the ground in new territories, entanglements and overtures. In this sense, following the two associations has allowed accounting for a geo-politics that is at

the same time local and global. The invitation suggests to continue this exercise of wondering where we would like to land and with whom we would agree to share a dwelling place.

Notes

[1] An early version of this paper was presented at the 4S/ESOCITE conference in Cholula (Mexico) on December 8, 2022. The panel "Bruno Latour: In Memoriam" was chaired by Emma Kowal and Leandro Rodriguez Medina, and featured Christopher Kelty, Sergio Sismondo, Wen-Ling Tu, Léa Maria Leme Velho, Dominique Vinck and the author. The author wishes to thank the chairs for the opportunity to process and publicly discuss Latour's legacy in her work. "Drawing Bruno Together" was instead the title of a panel in memoriam of Bruno Latour held at the IX STS Italia conference. The panel's title was suggested by Claudio Coletta. The panel was organized by the author and featured Madeleine Akrich, Huub Dijstelbloem, Paul Edwards, Noortje Marres, Alvise Mattozzi, Tommaso Venturini.

[2] I wish to thank Sarah De Rijke for having pointed out that the personal intake could work as an educational learning experience to be shared with contemporary students.

[3] Four years later I owed once again my thanks to Bruno Latour, but this time for a different reason. Upon my request, he accepted to host my Marie Curie Action application and made sure that the aptest colleagues supported its design and writing.

[4] I thank Assunta Vitteritti for pointing out this text to me. The rejection might not come as a surprise, given that the paper staged an imaginary dialogue between Latour and Haraway.

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Following Bruno Latour in Post-Critical Pedagogy[1]

Paolo Landri

1. Introduction

In the attempt to write this article, I have started by trying to address the following question: how can I add to what countless people have already said about Bruno Latour? The work of Bruno Latour will be, for long, a source of inspiration for many. During his career, he crossed many disciplinary boundaries, and it is thus not easy to define his work. Is it anthropology, sociology, or philosophy? Is he an ecological thinker, as some have underlined after his death? His scientific identity is indeed somewhat elusive. His biographical notes and institutional affiliations too, show his scholarship's complexity. I concur with De Vries (2016) to consider his research a conceptual and methodological repertoire for re-describing modernity, revisiting its Constitution, and elaborating a path for its radical reform or a way out. His work is, therefore, an essential reference in social science and, above all, a must-read for those interested in developing a nuanced understanding of contemporary societal challenges.

In order to enrich the current literature remembering Latour, in this article I will briefly describe what have meant for me following Latour. I will do this from the perspective of a sociologist who has contributed to circulating his work in education studies. Latour was not an educationalist; nevertheless, his work fostered and supported the development of new research networks between STS and education. Moreover, he was a highly appreciated teacher and developed a pedagogy to teach science and technology based on the de-scription of controversies. The goal of this article is to locate his contribution to education studies in his broad project of de/recomposing modern institutions. Latour was interested in revisiting

modernity, not in destroying it, thus offering a space where its institutions (including education) could be rethought.

In the following, I will briefly illustrate 1) how, as a sociologist, I initially gained interest and started to follow Bruno Latour's work, 2) how following Bruno Latour has led to the establishment of an STS-oriented area in studies of education.

2. Being interested in Bruno Latour

Bruno Latour's work first attracted me during my PhD in 1995. Departing from my sociology of organisation background, I was searching for a way to study schools without necessarily drawing on managerial or rationalist approaches. At that time, winds of reform were blowing over the world, leading to an expansion of the neo-liberal agenda and the new public management vocabularies and policy instrumentations (Lascoumes and Le Gales 2007). In this context, my research was a classical ethnography about the implementation of a reform within Italian primary education. However, my research was not strictly an educational ethnography. In fact, it probably could have been considered as a research-case at the crossroads of political and organization studies. During that time, I was in Naples, where I was working with Roberto Serpieri, through whom I started to become acquainted with Silvia Gherardi and Antonio Strati – and more in general with the Research Unit on Communication, Organizational Learning and Aesthetics (RUCOLA) at the University of Trento.

As a scholar operating at the intersection of political and organization studies, I also started to be curious about Scandinavian neo-institutionalism, and particularly, about Barbara Czarniaskwa's work (1997). Indeed, her discussions about the concept of "translation" seemed to be a promising direction to follow when rethinking the public administration reform in the context organization of primary schools in Italy. As she explains in her book, the idea of "translation" was borrowed from Bruno Latour. Drawing on this notion, it was possible to go beyond the idea of "diffusion" in the Neo-institutionalist reading of the reforms that ended to underestimate, or to negatively assess the frictions, the conflicts in the analysis of the implementation processes. A quick exploration of Latour's chain of references displaced my work in considering the sociology of translation and Actor-Network Theory.

First of all, as a sociologist trained with the idea of "actors" being implicitly and exclusively humans, I was shocked by the idea that non-humans could have an agency in social reality. However, it was also an invitation to see and study the world differently. At that time, there was dissatisfaction with the overemphasis on language in organization studies brought by post-modernism. Discourses, talks, languages, and other exquisitely "cultural" elements occupied the center stage of this kind of research, both theoretically and empirically.

This attitude quickly spread within organization studies, sociology, anthropology, and psychology. Many articles focused on language, identities, and subjectivities by privileging the implementation of case studies and qualitative research. In this context, the vocabulary of ANT appeared deeply transformative, inflating social science again with a wave of new materialism. Since then, the work of Bruno Latour, and more generally ANT, became the foci of my attention. I started experimenting with these vocabularies and participated in many re-

search projects, through which I was hoping to foster a wider circulation of his work in Italy.

It was with this aim that I published my book *L'innovazione nella scuola* (2000). In following this path, I also participated in the design and realization of *Tradurre le riforme in pratica*, edited by Silvia Gherardi and Andrea Lippi (2000), for which I wrote a chapter and which later on became an essential reference for the Italian debate on ANT.

At that time, it was not easy to be a Latourian or an ANT-ish researcher. First, there was a widespread misunderstanding of the acronym ANT in Italian academia. Not many scholars could see the differences between ANT and network analysis. To some sociologists it was only a new "French fashion": just a way to play the academic game of distinguishing oneself in the field. Also, a tendency for conservatism in the Italian scientific community pushed against newcomers bearing strange vocabularies and challenging basic assumptions in social science.

On the other hand, the use of semiotics and the tune-up of the ethnographic method of Bruno Latour surely helped to reconsider the limitations of current investigation in the field and disclosed many new possibilities for research. The chance of experimenting with a new vocabulary was appealing, although this would have led to inevitable clashes with more established paradigms in social sciences and to the risk of being marginalized within the academic field. I remember how some academics openly discouraged me from following the destiny of Mr. Latour! Even the scholars willing to explore new concepts and methodologies accused ANT of not being critical enough, of not understanding the role of power, and of being just another road leading to technological/material determinism (Gorur 2021).

Initially, Latour was exclusively associated with ANT and science and technology studies. As a reader, however, to me it was also clear that his work overwhelmed these boundaries. Even if he is rightly considered one of ANT's key authors and "fathers", his later publications clarified that his work assumed a much broader perspective. His critical appraisal suggested that his research interest was much broader. Books like *We Have Never Been Modern* (1993), and *The Politics of Nature* (2004a) showed that his project was in fact that of an anthropology of modernity. By drawing on several empirical studies on key institutions of modernity, he documented how the current dominant account of the modern condition was wrong. There was a persistent gap between how Moderns represent what they do and what they actually do in practice. This line of thought would later also have led to a new project (and book) called *An Inquiry Into the Mode of Existence* (2013), where Latour positively tries to answer the question: if we have never been modern, what have we been?

These shifts have sometimes dismayed even in his most passionate readers. As one of the results, the translation of his work in Italy has only been fragmentary. Since those interested in his work had heterogeneous backgrounds, the translations of his books were not always mindful of his trajectory. These limitations in the circulation of his work in Italy pushed me to edit an Italian translation of some of his books. I initially thought about translating *Aramis, or the Love of Technology* (1996), but then I was surprised when I stumbled upon a copy of *La Fabrique du Droit* (2002) in Paris, which I bought and immediately read. This book disclosed a very diverse view of his work. I was struggling to give the appropriate place for this work within the list of his publications. With the support of Domenico Lipari, I personally contacted Bruno Latour, who was happy to know that his book about law would appear in Italian. He also welcomed the idea of having an interview with him as an afterword.

At that time, the book had already been widely debated in France, and Latour sent me articles discussing and interpreting it from different perspectives. Eventually, thanks to Pasquale Gagliardi, who invited Latour in Italy for a seminar in 2006, we were able to realize the interview at the Fondazione Cini in Venice[2].

The Interview illustrates how the empirical work on law was part of a broader project comparing truth conditions in the European tradition (Landri and Latour 2011, 56). In the interview, he underlined how his earlier work on science and technology was just a necessary step within the broader endeavor of comparing modernity's key institutions. Whereas in his ANT phase, he was eager to follow "networks", now, in the After-ANT period, he was more interested in selecting network's "felicity conditions". As such law was a specific connector to "reassembling the social", similarly it was technology, religion, politics, and economics. In practice, he was anticipating *An Inquiry Into the Modes of Existence*.

After *Fabrique du Droit* (2002), other Latour's books and articles were translated into Italian. His ecological turn was in line with a renewed sensibility toward environmental issues pervading scholarly environments. Similarly to what already happened previously, many scholars pertaining to various disciplines were involved in projects of translation, inducing some inevitable heterogeneity. In this regard, I also engaged in some unsuccessful attempts to translate *Reassembling the Social*. Not many Italian sociologists were keen to support this project: for some, he was not a sociologist. Latour was and still is troublesome for the sociological community. Unsurprisingly, the Italian translation of *Reassembling the Social* was not edited by sociologists. This is unfortunate, since it could have helped to foster and revive an intense discussion about the future of sociology. By taking modernity as his central focus, indeed, Latour's work is a bench test for contemporary sociology.

Nevertheless, the aim of his research program was not going beyond modernity but to reinvent it. His work is not critical in the canonical sense. "Critics is always right!", he said many times, while in a well-known article he also underlined how "critique is running out of steam" (Latour 2004b). His program is rather post-critical since its intention is not to unveil, but to recompose a common world by leaving the issue of what a common world is permanently open. It is a way to abandon the modernist parenthesis and its dichotomic constitution (nature/culture; facts/value; human/nonhuman) without destroying modernity.

3. Latour and Education Studies

Following Latour means to be eager to embrace boundary-crossing and the development of unexpected associations, even in those fields of investigation he did not often attend. For me, this is the case of education. Bruno Latour was not an educationalist, and indeed he is more well-known as a sociologist, philosopher, and anthropologist. Apart from a small parenthesis at the beginning of his career, when he realized a sociological study of education, he never explicitly focused on the classical subjects of education, such as school, curriculum, or assessment.

In 1974, he published a research report about the ideology behind the concept of competence in the industrial context of the Ivory Coast (Latour 1974). He documented that the accusation of incompetence towards the local executive managers, when they substituted white

French managers in a colonial environment, could not be attributed to the "African mind" but to the failing school system of the Ivory Coast. Since Ivory Coast's schooling system was a copy of the French one, it only imported engineering discourse and not practices associated to it.

Latour concluded that competence is not something that resides in people's minds, but rather in a network. Here, he shared the idea of "situated learning", which would have been later further developed by anthropologists, social psychologists, and educationalists.

After that work, he moved to the study of the "laboratory life" and only indirectly touched on educational issues. Nevertheless, it would be a mistake to say Latour's work is irrelevant to education studies.

The extensive quotation of his work in education, not limited to STS scholars, confirmed its usefulness as a resource for thinking about the complexities of the contemporary landscape of education: a time when modern education displays its limitations. The role of ANT in creating a transnational network of scholars in education that actively promotes STS in education is undeniable. In Italy, after my initial work, a small ANT-STS community in education studies arose, also thanks to the effort and dedication of Assunta Viteritti. Together, we edited a Scuola Democratica special issue titled *Sociomaterialità in educazione* (2016)[3]. Before that, we also worked in previous research projects drawing on ANT vocabulary to describe the policy of school autonomy, where we paid attention to the agency of nonhumans in education. The attention to materiality led us to connect with researchers in the education field who can be considered antecedents of the approach, like Riccardo Massa, whose community of scholars develops post-humanistic accounts in education. Following Latour we reinforced connections between the sociology of education and education studies.

Internationally, following Latour was conducive to meeting other colleagues, like Jan Nespor, who was the first to develop a fully ANT study in education (1994), and Tara Fenwick and Richard Edwards, who were preparing a book on *Actor-Network Theory and Education* (2010). Attending the European Conference of Educational Research, I also met with Romuald Normand and Jean Louis Derouet (2000). Derouet knew Latour and his approach very well and already tried to lean on sociology of translation to study education policy and practice. Yet, Latour was more popular outside than inside France, where he had been severely criticized. Only on the international level was there some chance to create a space that could support the development of a favorable place for an ANT community. That was the case for the Network 28 "Sociologies of Education", where many ANT scholars have found an arena to present and discuss their works (see, for example, the EERJ Special Issue *Mobile Sociologies of Education*, Landri and Neumann 2014). Meeting Radhika Gorur was particularly important: she contributed internationally to the circulation of ANT and Bruno Latour's work in education policy (Gorur 2015).

Latour's contribution to education extended well beyond just ANT. In this case, however, his contribution is still waiting to be recognized. We can summarize the relevance of his work through the concept of *post-criticality*. In the after-ANT period, he was interested in a compositionist agenda. It provided some ideas, like the Parliament of Things, the focus on controversies and "An inquiry into the modes of existence" (AIME), that have stimulated the investigation of educational scholars on how to rethink education.

The Parliament of Things was a metaphor proposed by Latour (1996) to give a name to

the development of common worlds made up of hybrids, that is, the association of humans and nonhumans. Here, he reprised an old meaning of "thing" in English and other European languages, using it to point out to a meeting, a gathering, where something is made public.

By extending the analogy, schools too, are like a Parliament of Things. Desks, blackboards, seats, rooms, documents, circulars, teachers, headteachers, students and digital platforms are all "school things" defining complex associations of humans and nonhumans.

Further, the idea of "thing" allows the articulation of a thing-centred pedagogy (Vlieghe and Zamojski 2019) that goes beyond a teacher-centred pedagogy (where knowledge is imposed on students) and a student-centred pedagogy (where student's needs are at the centre). In a thing-centered pedagogy, the essential teaching gesture is making everyone attentive in the room toward subjects that become "subject matters". It clarifies that education is an intergenerational gathering between generations. As Hanna Arendt would say, it concerns the world's transmission and possibly its renewal. It is always about a thing, that is, something that has materiality on its own, that deserves to be given attention and to be passed on to the new generation. At the same time, a thing-centered pedagogy discloses the possibility of renewing the world or some aspects of the world when passing it on to the new generation.

The idea of the Parliament of Things suggests that the re-composition of a common world involves dealing with controversies. A focus on controversies is educationally fruitful and has led to developing a specific kind of pedagogy that Latour describes in *Cogitamus* (2010).

Except for a chapter in *Reassembling the Social* (2005), *Cogitamus* is the only book with an explicit educational goal. Here, Latour designs a course at a distance for an imaginary German female student. In doing so, he writes six letters to help the student to attend the course and develop her expertise in science, technology and society. This epistolary course is builds upon the physically attended course that Latour previously delivered at Science Po under the title "Humanités Scientifiques". Moreover, and not by chance, the six letters mirror the six chapters of Descarte' foundational book of modernity.

In *Cogitamus* (2010), Latour suggests an inquiry-based method of learning. An inquiry complemented by dialogue. Knowing is not an individual affair (*cogitos*, according to Descartes), rather it is a collective endeavor (*cogitamus*). The proposed inquiry method envisages the student's participation in the knowing process mediated by a notebook that collects many materials (articles, documents, etc.). Latour's letters contain the theoretical and methodological guidelines to give a sense of the exploration and boundary crossing between science and society. The tone of the letters is informative, but also ironic. The teacher draws on maps, illustrative schemes, and examples. Pedagogy, here, is equivalent to the cartography of controversies presented in academic articles and developed by Latour together with his team collaborating in an EU-funded project (MACOSPOL[4]) (Venturini et al. 2015). An important aspect of the cartography of controversies is "making things in public" that Latour carried out by drawing on alliances with arts and digital devices. The underlying logic is to counter the reductionist and limited account of science and technology in modernity. The goal is not to deconstruct but rather to recompose science, technology, and society differently.

Regardless of the importance of this latter goal, it is somewhat surprising that education is not fully included in "An inquiry on the modes of existence". In AIME, Latour affirms that:

> humanoids become humans – thinking, speaking humans, by dint of association with the beings of technology, fiction, and reference. They become skillful, imaginative, capable of objective knowledge by dint of grappling with these modes of existence. (Latour 2013, 372)

However, it took the work of Jonathan Tummons (2021) to argue that "Education" should be on the list of the modes of existence. With Tummons's article, education passes the test of AIME cosmology, but what counts as "educational" in education in this inquiry is vague.

The "educational" aspect in Latour emerges more clearly in the latest production, in books like *Down to Earth* (2018) or *Facing Gaia* (2017), when he brings ecological materialism as an antidote to counter the nature-culture dualism (Landri 2023). In those works, and in line with his pedagogy of controversies and his love for science and technology, he seems to orient toward a thing-centered pedagogy as a felicity condition for the institution of education in the new climate regime: an educational approach dealing with the permanently open question of renewing our common world.

Is Latour arguing that education is inherently political, as argued in critical pedagogy? It is unlikely, by considering his criticism of the critical approach. Why is he convinced that education is not a specific way of reassembling the social with a proper felicity condition, like law, technology, and religion? These questions open new lines of investigation and would need additional analysis for his work to be properly addressed.

4. To conclude

In sum: follow an actor, and you will find a network! Isn't it one of Latour's well-known teachings?

Following Latour has been generative of new relations and associations across disciplinary boundaries and countries. It has solicited a detailed redescription of education through the emergence of the studies of STS in education that are promising resources in revisiting modern education. Educationally, ANT and Latour invite the development of a thing-centered pedagogy that challenges human exceptionalism and suggests acknowledging the mutual constitution of humans and nonhumans. Further work with and near Latour is needed to grapple with the complexity of the current educational scenarios and develop perspectives to reinforce educational institutions and cope with emerging subjectivities in the new climate regime.

Notes

[1] I would like to thank Radhika Gorur for her comments. Thanks also to Fabio Maria Esposito for his help on a previous draft of this article.

[2] A transcription of the interview was also published in *Tecnoscienza* (Landri and Latour 2011).

[3] In English: "Sociomaterialities in education".

[4] See https://medialab.sciencespo.fr/en/activities/macospol/.

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Bruno Latour and Artificial Intelligence

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Abstract
This scenario discusses generative AI in light of Bruno Latour's sociology of technology. It considers why Latour showed little interest in the simulation of intelligence and how connectionist AI fails to meet his condition for scientificity but offers a fascinating writing mediation. AI is most interesting not because it emulates human thinking or writing, but because it differs from them. Drawing on actor-network theory, this scenario argues against the idea of machines becoming detached from their creators and highlights how AIs can only exist through the support of their human assistants. The risks associated with these technologies do not come from an improbable singularity, but from their embedding in the dull and exploitative industry of digital attention economy.

Keywords
artificial intelligence; actor-network theory; machine learning; deep learning; generative AI.

1. Introduction

Since his disappearance in October 2022, I have been missing Bruno Latour intensely, as have all those who knew him. What we miss the most, I believe, is his unwavering intellectual compass, his ability to see through the "foam of events" (as Lippmann put it) and identify what matters in the long run. My ache for his compass has only increased in the last few months, as generative artificial intelligence has suddenly become *the* matter of concern in digital societies. The recent leap forward in AI's ability to perform advanced tasks (translating and writing texts, designing images, creating videos, etc.) has struck a deep chord in our collective imagination and has become the pivot of a surge of hopes and worries. Some see it as the miracle solution that will unlock unlimited intellectual progress, optimize the allocation of resources and become the faithful companion of our thinking. Others (and most social scientists tend to fall into this category) are increasingly wary of the prejudices linked to this technology, its possible abuses, its consequences on labor, copyright, public debate, education, etc. STS scholars have already begun to investigate these imaginaries and their roots (cf., for example, Suchman 2008; Katzenbach 2021; Bareis and Katzenbach 2022; Ferrari and McKelvey 2023; Veale et al. 2023).

But what would Bruno make of it? I keep asking myself: what would he think is the story here? What should we hope or fear, or dismiss as nonsense? I am sure that Bruno would know. After all, no one has so skillfully woven anthropology, philosophy, sociology, and political science to unfold the imbroglios of contemporary technology.

Sadly, we can't ask for his help on this one. All we can do is engage in a thought experiment that (somewhat ironically) resembles a peculiar ability of generative AI: we can guess what Latour might have written about these technologies. We could even ask the AI to do so. And ask I did, but (somewhat reassuringly) obtained no useful insight – though the machine did a good job of reproducing Latour's humor, though maybe in a bit of a caricature:

> Ah, the generative artificial intelligence, a marvel of human creation, yet an entity in its own right, weaving its digital tendrils into the fabric of our society. As with many things, it is neither entirely of our making nor entirely separate from us, inextricably linked, yet perpetually distant... We teach them our ways, our languages, our desires, only to be confronted with their peculiar modes of thought, their uncanny reflections of our own selves. Their very existence forces us to renegotiate our place within the entangled web of actors, human and non-human alike. And thus, we find ourselves caught in a dance with these digital phantoms, a perpetual *pas de deux* between master and servant, creator and creation. And who is to say, when the music fades and the stage lights dim, which role we shall assume? (ChatGTP4 impersonating Latour)

Not bad as the style goes, but quite shallow in meaning – as one would expect from a machine that (as advertised) is good at writing by so-so at reasoning. So, in this scenario, I will make the attempt myself, scraping ideas from the few writings where Latour engaged with similar questions. To be sure, this will entail some betrayal, not only because (as Latour argued multiple times) translation is always a form of treachery (*traduction trahison*), but also because Latour did not seem particularly interested in AI in the first place.

Sifting through the vast collection of his writings, I found only one paper dedicated to AI – a theatrical dialogue with novelist Richard Powers about HAL and the Turing test (Latour and Powers 1998). He dedicated the last part of his career to the enormous threats posed by the ecological crisis and the enormous political work necessary to rebuild a common world. From this perspective, I believe he would have considered AI as a distraction, or worse he would have been appalled by the enormous quantity of energy consumed by these systems. Not unlike the dream of colonizing Mars or escaping to the metaverse, criticized in his Critical Zone exhibition, he might have regarded the efforts invested in creating future artificial intelligences as a means of procrastinating the much more difficult and urgent task of cultivating the present social intelligence.

This raises a moral (or rather political) dilemma: if Latour might have seen AI as a distraction from the pressing issue of Gaia, is it fair to invoke his thought to write about it? I believe so, as I believe that this is not just an exercise in style. For reasons that I hope will become clear, thinking with Latour (or "as Latour") can help unfold the peculiar nature of generative AI.

2. AI's possible role in science and social sciences

Latour's relative indifference towards AI is not surprising. Throughout his career, he consistently admired science and technology for their ability to make us sensitive to natural and social phenomena, rather than for their capacity to artificially reproduce them. Latour cherished artificiality, to be sure ("the more constructed the more real", Latour 2003a), but for its capacity to renew rather than to reproduce. He was an "amateur of science" (Latour 1993a), but I don't think AI, and deep learning in particular, would have qualified as such in his mind. Famously, Latour described the scientific method as a reversible chain of transformations: "an unbroken series of well-nested elements, each of which plays the role of sign for the previous one and of the thing for the succeeding one" (Latour 1995, 56). The explicitness and reversibility of this chain of "reference" was to him nothing less than "mode of existence" of science (Latour 2013). By such a standard, I doubt that the computational blender of generative AI can be considered as scientific. Indeed, the success of connectionist AI and its leap forward from symbolic AI stems precisely from the choice of sacrificing transparency in exchange of efficacy (Cardon et al. 2018). At its best, generative AI represents the triumph of what Latour (2013) calls "double click": the ultimate success of technological systems that become invisible and inscrutable because of their own efficiency. But, at its worst, it also resembles the "double click" ideology, the erroneous belief that knowledge can be obtained immediately and at no cost.

Latour was a fan of digital methods, but remained skeptical of simulations and models (Venturini et al. 2015). To him, "The Whole is Always Smaller Than Its Parts" (Latour et al. 2012), and by "smaller" he meant "less interesting". He never wanted to compute or aggregate masses of data points, but was captivated by the idea of observing them individually. For him, this was the real advantage of digital research (Latour 2007) and the purpose of the quali-quantitative approach he proposed (Venturini et al. 2017; Venturini 2024). He began his career as an ethnographer and never gave up his penchant for keen observation and painstaking description. He never cared about distant reading and I doubt that AI distant writing would have held much appeal for him *as an analytic tool*.

On the other hand, he would have been intrigued by AI as a *writing* tool. As well-known, Latour was passionate about the practice of sociological writing, which he saw as the equivalent of natural sciences laboratories. To him, writing was our chain of reference:

> If the word "scientific" can be applied to social science, and I think it does, it is above all for the writing work that we are obliged to do for each field differently. This is what makes "objective" our theses or our reports or our books. (Latour 2014, *my translation*).

Interestingly, in such a struggle, thinking and writing are inseparable, forming a practice that Latour describes with words that closely reminds the functioning of generative AIs:

> You are thinking because you are writing, and the writing makes you think... Writing makes one think, because you write stupid things. On the next page, something happens, and on the next. It comes out of this weird thing [laughs] that I have a lot of trouble teaching my students in my writing workshops: "If you don't write you aren't thinking". (Latour in an interview by Coccia 2021).

Large language models indeed work by reading a prompt and then predicting the bit of text most likely to follow, and then the next and then the next ("on the next page, something happens, and on the next").

Because of this functioning, some people argue that AIs are not really reasoning but merely writing. I think Latour would have found this distinction specious. Instead, what he believed to be unique to human writing is the capacity to return to the same text over and over again in order to reread and rewrite it, especially when this is done collectively in an in-person writing workshop or in a remote dialogue with other authors. But Latour would not have balked at the notion of introducing a machine into the mix. Quite the contrary, I believe he would have liked the idea of an interactive writing tool that is less obedient than a typewriter, as this may add another layer of resistance, and thus reflexivity, to the thinking of the researcher who uses it.

3. AI and the complementarity between human and technological agents

Another reasons why I am convinced that Latour's reading of AI renaissance would have been quite down-to-earth is that he explicitly said so, in the only text he dedicated to this technology:

> I don't understand the fuss about futuristic machines at all. Imagine a Turing test for shoveling, here is a human worker shoveling earth and here is an earth-moving machine, can you tell them apart? Yes, of course, the second one is immensely more powerful and drives tons away instead of kilos. What would be the lesson to draw? Why would we build machines if it were not to make them immensely more powerful than ourselves? To make us collectively more powerful than we were in the past. What is true for shoveling, is true for intelligence and also for emotion. Is not Hollywood such an immensely powerful machine, to be able to produce tears, passion, love and fright? How bizarre is it, to imagine a Turing test where the two halves are on an equal footing, when all what we strive for, on the contrary, is *inequality*? But why do we conclude from this inequality that machines are escaping us, and dominating us? (Latour and Powers 1998, 186, *emphasis added*).

The quote operates a classic Latourian move, challenging the exceptionality of one technology (AI) by showing its fundamental resemblance to other technologies (the shoveling machine) and societal apparatus (Hollywood as an emotion machine). It says: artificial intelligence is just another technology; it is different from previous ones (for every technique is unique in some way), but not extraordinary.

In the discussion from which this quote is extracted, the sci-fi novelist Richard Power repeatedly tries to convince Latour of the disruptiveness of an AI capable of beating the Turing test and the doubts it casts on our own thinking. If a mindless machine can *pretend* to think, how can we be sure that humans are not doing the same?

> Am I, myself, capable of passing the Turing Test honestly, or do I do so only by cheating? Is consciousness itself a form of "cheating", whereby I grace with the most charitable interpretation the semblance of intelligence burbling up from my lower-level machines? (*ibid.*, 182).

Latour seems utterly and unsurprisingly unimpressed by this argument. After all, half of his actor-network theory (ANT) revolves around the idea that anything that acts socially is a social actor – a title that should thus rightfully be granted to machines and to all sorts of non-human beings (Latour 2005). Latour famously wrote that the actions of a speed bump, or a "sleeping policeman" as sometimes called, are not fundamentally different from that of a human policeman: they both slow the traffic down (Latour 1994a). True, the sleeping policeman has no soul, intentions or emotions, but this does not prevent him from acting in society and thus to be a social actor.

To be sure, Latour never said that human actors and non-human actors are the same. Of course, they are not. A sleeping policeman is much cheaper to install and maintain and can work 24 hours a day without complaint. That's the whole interest of technologies: because they are different from humans, they can deal with the same tasks in ways that are different and sometimes more efficient. Precisely because their inner workings are different from those of humans, the shoveling machine can move more earth than a human shoveler and the Hollywood machine more emotions than a human storyteller. In the exact same way, generative AIs do not think, write, or draw as humans do and that is why they are interesting.

Generative AIs are most remarkable in that they act differently from humans. Like shoveling machines and sleeping policemen, they are more focused and relentless. Humans are eclectic agents always engaged in a broad spectrum of activities. This makes them infinitely fascinating and adaptable, but also messes with their focus. Even the most dedicated professionals can only do their job for a few hours a day because they also need to eat, rest, talk, play, give and receive emotional support, and so on. Machines tend to be more specialized, which allows scaling up their efforts (the shoveling machine could not move so much earth, if it also had to pick flowers or play cello).

The keyword in the quote above is "inequality". It captures the idea that the value of AI (as of any technology) comes from its alterity. This is an excellent example of Latour's intellectual yoga: a posture that is both balanced and stretched outside the two commonplace positions we take when considering AI. On the one hand, the fear of a technology that could overpower us – as if there were not thousands of other technologies already overpowering us. On the other hand, the temptation to belittle AI by marketing it as a submissive assistant (as neo-Marxist scholars duly noted, casting AIs as inexpensive and non-unionized knowledge workers really speaks to the dullness of contemporary capitalism).

In other words, contemporary AIs are interesting not because they can succeed in Turing's imitation game, but because they fail it productively. How do you know that a generative chatbot is not human? By its ability to answer questions on any knowledge domain, fielded by millions of users in dozens of different languages. No human could do that, and that's precisely what makes AI intriguing.

4. AI as an actor-network

If, as discussed above, Latour was wary of the aim of the Turing test, he was even more skeptical of its conditions. Where Powers thinks that machines and humans may equally

cheat by mechanically emulating thought, Latour thinks that it is the test that is cheating by imaging a set up in which both the machine and the human are isolated and connected solely through a teleprinter:

> The idea of a test matching a naked, isolated intelligent human against an isolated naked automated machine seems to me as unrealistic as imagining that we are here alone talking through email "naturally", "directly", without any mediation. Things and people are too much intertwined to be partitioned before the test begins, especially to capture this most heavily equipped of all faculties: intelligence. (Latour and Powers 1998, 180)

This critique of the Turing test resonates again with ANT. If the first half of this theory encourages us to regard everything that acts as an actor, the second posits that every action results from a complex network of interactions (Venturini and Munk 2021, 124-136). This is why ANT is also called "sociology of translation" (Callon 1986), because one of its core ideas is that no program of action can ever succeed when carried out by a single actor. Alliances and compromises are necessary to complete the smallest task (cf. Bijker et al. 1989 and Bijker and Law 1992). Discussing Hutchins' (1995) book *Cognition in the Wild*, Latour argued that this is very much true of thinking as of any other type of action:

> [...] cognition has nothing to do with minds nor with individuals but with the propagation of representations through various media, which are coordinated by a very lightly equipped human subject working in a group, inside a culture, with many artifacts and who might have internalized some parts of the process. (see Latour in Keller et al. 1996, 57)

and

> Laboratories think, communities discover, disciplines progress, instruments see, not individual minds. (*ibid.*, 62)

Latour took this idea a step further. Since agency is defined by action, then the relational nature of actions implies the relational nature of actors. Latour explored this idea in many of his writings, but perhaps the clearest example comes from his reading of the controversy about gun control. Are guns neutral tools which can be used for good or ill depending on who wields them (as in the National Rifle Association's slogan "guns don't kill people, people kill people") or are they inherently harmful instruments destined to realize their destructive function? Neither, answers Latour, guns have no essence separated from the persons wield them, but (and here is the real kicker) the same is true for their wielders:

> Essence is existence and existence is action. If I define you by what you have (the gun), and by the series of associations that you enter into when you use what you have (when you fire the gun), then you are modified by the gun – more so or less so, depending on the weight of the other associations that you carry. This translation is wholly symmetrical. You are different with a gun in hand; the gun is different with you holding it. You are another subject because

> you hold the gun; the gun is another object because it has entered into a relationship with you. (Latour 1994a, 33)

Hence the treachery of the Turing test. To pretend that there can be such a thing as an AI separated from the infrastructure that supports its existence, which includes many other machines as well as many other humans. And, symmetrically, that there can be such a thing as an equally isolated human tester. So much for the idea of the "singularity", the hypothetical moment in which AI will break free from its human creators! If the history of technology has taught us anything, it is that nothing ever breaks free from anything. Quite the contrary, since prehistory and maybe even before, the evolution of humans and technologies is a chronicle of mutual entanglement and escalating interdependence (Latour 1993b; 1994b). The myth of the golem, the creature that emancipates and takes over its own creator has never been anything but a myth. Not because of the creature's virtues or flaws, but because we, the creators, have always been a Frankenstein of our own. An actor-network, if you wish.

5. Iconoclasm, labor exploitation and the fabrication of AI

The misled obsession for AI's autonomy recalls another fallacy that Latour questioned earlier in his career, that of iconoclasm – i.e., the belief that religious images cannot be authentic if they are fabricated. In his exhibition on the subject, Latour disputed the idea that acheiropoietic icons (not made by human hands but created miraculously) hold the highest value. Instead, he argues:

> that the more human-work is shown, the better is their grasp of reality, of sanctity, of worship. That the more images, mediations, intermediaries, icons are multiplied and overtly fabricated, explicitly and publicly constructed, the more respect we [should] have for their capacities to welcome, to gather, to recollect truth and sanctity. (Latour 2002, 18, 20)

The exhibition extended this idea to science – claiming that the more and the better scientific facts are fabricated, the more they connect to their objects – and to politics, whose art lies precisely in stitching together an improbable community that would not exist otherwise. Here we see that Latour's skepticism for autonomy and his interest for associations becomes normative. Not only he sees networks everywhere he looks, but he is also convinced that such a relational organization is *right and just, our duty and our salvation*.

If religious, scientific and political facts should be valued for their careful fabrication and their network of associations, why should AI be any different? In his conversation on AI, Latour connects the two ideas: "I don't understand immaculate conception, more exactly I have great respect for the strange virginal dogma of the Church and cannot have any patience with its application to machines" (Latour and Powers 1998, 186). Only AI zealots can believe in the self-sufficiency of intelligent machines. We, humans, are intelligent machines and we are not self-sufficient at all. Examine any modern city and you will witness an incredible infrastructural effort necessary to bring in the food, water, heat we need and bring out all the waste that we

produce. And that is just what's needed to keep us alive (Latour and Hermant 1998). If, on the top of that, you also want humans to be able to think, then be ready to add transportation, electrical and communication cables, payrolls, education systems, museums, libraries, theaters... and, of course, all the political, social and administrative institutions necessary to manage them.

The same is obviously true for AIs. According to some observers, the recent step forward in AIs capacities comes from the alignment of a plurality of elements of different nature (Huang 2023): social (the explosion of user-generated content used to train the algorithms); cultural (the shift from symbolic to connectionist AI); technological (the repurposing of graphics processing units); mathematical (the introduction of "transformers" with capacity for parallelization and self-attention); financial (low interests rates allowing to invest in experimental project) etc. Thanks to this heterogeneous network of allies, contemporary AI can do things that were unimaginable for their less plugged-in predecessors. And that's not all, by flipping the myth of the self-governing AI on its head, generative AIs are amazing not because they are autonomous, but because they are wired to a vast socio-technical infrastructure.

This dispels the fuss around deep and unsupervised learning. While these expressions signal an important discontinuity from earlier approaches, they do not mean that AIs are capable of learning by themselves. They just mean that human intervention has been displaced. In the older "symbolic approach", experts were consulted to formulate explicit rules to be fed into the machine. In the current "connectionist approach", the machine is given a very long series of examples and ask to detect patterns in them (e.g., that Latourian texts tend to revolve around words such as networks and associations, while Bourdieusian texts around as power and capital). This learning is said to be "deep" (or black-boxed) because the algorithm generated by the learning does not have to be explicit or understandable by a human. It is said to be "unsupervised" if the examples have not been tagged by human coders (e.g., no one told the computer which texts were by which author, it discovered this by noticing their signatures).

Clearly neither "deep" nor "unsupervised" mean autonomous. Quite the contrary, both require the help of a small army of mathematicians, data scientists, engineers, user experience designers, system managers, company managers, venture capitalists, etc. Commenting Deep Blue victory against Kasparov, Latour (1997) observed:

> They say: homo sapiens against the machine. Quickly said. Rather, it's homo sapiens in one form (world chess association, Kasparov, hundreds of years of gaming tradition) versus homo sapiens in another form (chess games from throughout history in memory, the millions of hours of work accumulated by hundreds of IBM programmers, the hundreds of years of experience in PLCs).

Also, machines need vast volumes of examples to learn from, which need to be generated by humans. Some algorithms are trained by "adversarial learning", when two or more machines are asked to play against each other to improve their performances, but this only works for tasks (such as security attacks or chess games) whose success is easy to define. While there are clear rules to determine whether a chess game lost, it is difficult to say what an interesting text reads like – so you cannot just let two chatbots discuss to improve their conversation. Instead, you need a huge army of humans producing contents that the machine can learn to imitate.

Machine learning is only as good as the data it learns from. This is why standard datasets such as *ImageNet*, *BookCorpus*, *WikiText*, and others are keystones to AI (Denton et al. 2021). Obviously, none of these datasets is autonomous, unsupervised, or self-assembled. Quite the contrary, all of them have required a massive human investment for the production, harvesting, cleaning, and labeling of their data (Pasquinelli 2019). These activities have often been crowdsourced using micro-labor platforms exploiting workers in the Global South (Tubaro et al. 2020) or ripping the Web without the slightest recognition or remuneration. None of the fan-artists filling the galleries of *Deviant Art* or *AO3*, the contributors editing the entries of *Wikipedia*, the developers providing advice on *Stack Overflow*, and in general none of the users posting content online did so with the intention of satiating AI's appetite for examples. Some artists are beginning to file lawsuits against the unauthorized and uncompensated use of their work, but their chances are uncertain. No company in the world has the money to pay for the gigantic amount of content fed into AI training datasets and courts and governments may be hesitant to cripple this nascent industry. Not to mention that the cloud-based nature of this technology makes it easy for companies to move to less regulated countries. Talk about barking at the wrong tree! We worry that AI might emancipate from its creator and forget that AI companies are so dependent on our input that they are ready to steal it off from us.

As Latour argued in many of its writings, it is the individual machines that we should worry about, but the sociotechnical systems in which they participate. This understanding radically changes our means of resistance. If we fear the menace of a rogue machine, then the best we can do is try to unplug through math or engineering (as in many sci-fi movies). If we oppose an industrial conglomerate, then our weapons are economic incentives, legal provisions, and societal mobilization (admittedly a lousy sci-fi movie!). *Suivez le réseau!* ("Follow the network!") would say Latour, and his idea has not lost a bit of relevance.

6. AI's mode of existence

So far, I have reflected on AI in the light of the general Latourian sociology of technology, yet one can also use his philosophy to pinpoint how generative AI is different from other technologies, its distinctive "mode of existence" as Latour would say. Here, Latour can be useful not only to social scientists but also to data and computer scientists.

In *An Inquiry into Modes of Existence* (2013) Latour suggests that, in order to understand the nature of beings, we need to examine how they act or, more precisely, the "felicity conditions" allowing to judge whether their action is successful. This idea comes of course from the philosophy of language (Austin 1962; Searle 1969), but Latour gave it a more existentialist meaning. Saying that the scientific method revolves around building reversible chains of reference means that scientific facts exist only as long as a connection between natural phenomena and their description is maintained. Lose this connection and your fact goes poof.

The felicity condition of technology in general is the replacement of human actions by non-human ones through what Latour calls: "the technological detour... [that] makes it possible, not to do something, but to *have something done*" (Latour 2013, 229, *emphasis in the original*). Crucially, however, since this is a detour and not a simple delegation, the thing that

used to be done is now done differently. An excavator does not just move more earth than a human, it also moves it differently, just as Hollywood moves emotions differently from a human storyteller. This also applies to AI, which is interesting precisely because its way of drawing and writing is different from that of humans. But different *how*?

Here, I believe, we should differentiate between the experimental development of generative AIs and their current and near-future industrial applications. Technologies in the laboratory are not the same thing as technologies on the market (Latour 1987). In the laboratory, generative AI is judged through what is called "reinforcement learning", that is by asking human evaluators to judge AI's answers. The need for such external validation is far from obvious. If we believe in the idea of a self-teaching AI, why should we add yet another army of humans, this of judges, on top of those that already produced, harvested and cleaned the examples the machine learns from? Why not let the machine establish its own felicity conditions?

Interestingly, this was a pragmatic call. Reinforcement learning was introduced after early AIs trained with content pulled from the Web ended up embracing racist and chauvinist stereotypes and, in some cases, extreme hate speech. This shouldn't have come as a surprise: the Web can be a toxic place and many of the training datasets were laden with biases (Crawford and Paglen 2021; Bandy and Vincent 2021). Thus, the dream of AI's autonomy was once more betrayed and more human connections were added to make the learning a bit less automatic. Incidentally, this has been noted and objected by right-wing groups that believe that their hard-fought online influence should not have been reinforced away. And these groups are now engaged in developing new AIs more strongly associated with their values. Once again, the problem is not AI's autonomy, but its associations.

If human reinforcement defines the felicity condition of AI *in the laboratory*, nothing assures that it will keep defining it *in the market*, where, I am afraid, felicity conditions are quite different. Indeed, if the Web is often a toxic place it is not only because it is full of toxic people, but also because the infrastructures that handle the circulation of online contents are, in many ways, partial to toxic content. To understand why, one needs to remember that the business model of most online platforms is advertising. Contemporary digital technologies are rooted in the attention economy of digital marketing and, in this economy, content that is outraging, hyper-partisan, sensationalist or otherwise attention-grabbing is highly favored (Venturini 2019). As candidly admitted by one of the creators of the neural-network recommendation algorithm used by YouTube:

> In addition to the first-order effect of simply recommending new videos that users want to watch, there is a critical secondary phenomenon of boot-strapping and propagating viral content. (Covington et al. 2016, 193).

Sure, generative artificial intelligence is not only used for tasks related to online attention economy, but consider this: it is trained on content generated by this economy; it is financed and dominated by the same companies that rules this economy; and generally, more and more social activities are migrating on the technologies (phones and computers), infrastructures (the Web and the Internet) and metrics (likes and shares) that supports this economy. What do you think will likely happen?

What is already happening is that generative AIs are being used to produce contents whose felicity is ultimately evaluated not by some human *arbitrer elegantiae*, but by a sociotechnical system composed, human influencers, social media platforms, online advertisers *and* deep learning recommendation algorithms. In line with McLuhan's prophecy: the "message" of all new media and technology is its way to "amplify or accelerate existing processes" (1964, 8). We will soon be in a situation in which generative AIs create content that humans pick and share, hoping to please recommendation AIs and thus be widely circulated online, thereby gaining a higher probability of influencing the further AI training. Mind you, it is not the circularity of the process that worries me (this is not another phony singularity argument); it is the fact that this cycle risks being steered by the very dull felicity conditions of maximizing our addiction to digital advertising. God forbid!

7. Conclusions

This scenario explored generative AI through the lens of Bruno Latour's philosophy of technology. It started by listing a few reasons why Latour did not seem particularly interested in AI. I noted that the project of simulating human intelligence feels utterly out of sync with its latest interest in the ecological crisis and its political consequences. I observed that the opacity of machine learning is at odds with Latour's definition of science as a reversible chain of reference. And I remarked that, as an ethnographer and someone obsessed with details and outliers, he would have disliked the black-boxed aggregation of deep learning. If anything, Latour might have appreciated AI as a writing tool, an instrument capable of quite subtle language games, a skill that he saw as crucial to research in social sciences.

Apart from what Latour might have liked or disliked, a Latourian perspective helps bring into focus the threats and promises of AI. Unlike what the Turing test or the idea of the singularity suggests, AI is not separate or separable from the vast network of technological, financial, and organizational supporters that maintain its existence. Far from being autonomous, AI relies on a vast army of human allies, which includes the scientists and engineers who tweak its models, but also the people who produce and prepare its training dataset and who correct the relevance of its responses. Rather than fearing that AI might break free from us, we should worry about how AI is embedded in the infrastructures of the digital attention economy and aligned to the goals of digital advertising.

Yet, not all hope is lost. One of the most important things that I have learned from Latour is that the dynamics of science and technology are always bound to defy our expectations. Resulting from a multiplicity of unpredictable interferences, the technological detour always takes us to places we did not anticipate. This cast an interesting light on the much-discussed issue of "AI's hallucinations": the tendency of generative machines to *extra*polate from their training on and offer outputs that, though plausible, are factually false and sometimes wildly delusional. In the early stages of generative AI, this was considered a fascinating feature – so much so that one of the first image generators was proudly named *DeepDream*. Yet as the technology matured, hallucinations have come to be considered a source of misinformation and a threat to public debate.

AI fantastic extrapolations are indeed a serious problem, but only if we accept that AI can serve as a reliable substitute for newspapers and text-books or, even worse, for journalists and school teachers. As Latour taught us, such an idea is both false and dangerous. No technological being can ever serve as a neutral substitute for another being (be it technical or human), and technological replacement always comes with a profound transformation of the situation, that it is better to understand than to deny. Rather than fighting AI hallucinations (in the misplaced hope that AI can be turned into a cheap substitute for intellectual labor), we should cherish its capacity for creativity. This is exactly what Latour did, drawing a parallel between machine intelligence and critical thinking:

> What would critique [and AI] do if it could be associated with more, not with less, with multiplication, not subtraction. Critical theory died away long ago; can we become critical again, in the sense here offered by Turing? That is, generating more ideas than we have received, inheriting from a prestigious critical tradition but not letting it die away, or "dropping into quiescence" like a piano no longer struck. This would require that all entities, including computers, cease to be objects defined simply by their inputs and outputs and become again things, mediating, assembling, gathering many more folds... Then we would have gone for good beyond iconoclasm. (Latour 2003b, 248)

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Picturing Ecology: Photography and the Birth of a New Science

by Damian Hughes (2022) Singapore, Palgrave Macmillan, pp. 491.

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Worldwide known personalities like David Attenborough made wildlife documentaries one of the main media to visualize more than human life through the mediation of photography, TV networks and storytelling. Among some researchers, the progressive unfolding of these visual media has given rise to what Jim Igoe (2017) calls "nature of spectacle", where entertainment, environmental policy and consumerism have found a merging point. However, wildlife documentalists were transforming a visual sensitivity inherited from the pioneers of ecology and photography in Britain. These pioneers were trying to create a new view of science and life diversity since the late nineteenth century that remains influential to our current days. In his most recent book *Picturing Ecology: Photography and the birth of a new science*, Damien Hughes invites us to witness the work of those early ecologists that shaped the underpinnings of their discipline as a visual science. Throughout its more than 400 pages, the author, a seasoned field ecologist and photohistorian with decades of experience, develops what he conceives as a "visual perspective" to show us how photography mediated the embodied encounters of ecologists with plants to configure the knowledge objects of one of the most influential sciences of the twentieth century.

Consisting of seven chapters, the book slowly unfolds a composite picture of ecology's history that Hughes elaborated for his readers. The first four chapters set the theoretical and historical grounds that help to situate one of the most important arguments of the author: the strong visual basis of early ecologists' practices that facilitated their task of configuring "vegetation" as their central knowledge object. The last three chapters take this point further by paying close attention to the uses of photography in the practices of field ecology, and how photography served as a platform to negotiate common understandings of knowledge objects in ecology. The book is based on visual and textual sources that included notebooks, journals, correspondence, photographs, and publications from early botanists in the United Kingdom and Europe from 1870 to the early twentieth century. According to Hughes, previous work addressing the role of images and representations in science (Amann and Knorr-Cetina 1988; Coopmans et al. 2014; Daston and Galison 1992; Lynch and Woolgar 1990) assumes that the aim of scientific representation is to "render the invisible visible" (p. 9). For Hughes, that means a selective approach that emphasizes the use of extraordinary images at the expense of

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historical and scientific context. That is why for him the book seeks to articulate a different perspective that highlights the agency of photographic practices and their role configuring knowledge-claims and objects in the social practices of science.

From the very beginning in Chapter 1, the author quickly distances himself from any essentialist and realist account of photography. This helps him to problematize the commonplace assumption that photography's function in sciences is the progressive unveiling of an objective and transparent record of natural phenomena, like vegetation in the case of ecology. The author's aim is not to engage with that kind of assumptions to criticize them, he rightly does not take that direction, because his efforts are devoted into situating a different departure point to study the role of photography in the practices of early ecologists. This is what enables him to delineate a route for his analysis of the social and epistemological agency of photography in the following chapters. Once paved that way, Hughes can more easily consider the status of photography in ecology as negotiated and contingent. This basically means that photography can raise questions concerned with the formation of disciplines, research agendas and as a rhetorical space for negotiating knowledge objects and evidence.

In this regard, Chapter 2 draws the contours of a visual history for ecology. Taking us back to Alexander's von Humboldt expedition in South America in the early nineteenth century and the first vegetation surveys by British ecologists in the 1890s, Hughes advances his visual analysis for understanding the origins of ecology. As a discipline, it was commonly associated to the scientific study and investigation of "vegetation" in the twentieth century. However, that definition works better on paper than in practice and history. Following Hughes' account, the systematic study of vegetation required in the first place to configure vegetation as a knowledge object. This would be achieved through the different pictorial strategies by Humboldt and other early ecologists, who were trying to understand plants *en masse* and their associations instead of focusing exclusively on individual species as it was typical of botany at that time. The challenge for these pioneers was to turn their field experiences observing plants in the field into compelling evidence informing "vegetation" as a new scientific object. For doing so, they translated their field observations into textual descriptions including different factors considered as important to study vegetation, like for example botanical and physical information. But crucially, it was also important for these scientists to include visual information, which helped them to understand and study vegetation as an eminently visual knowledge object. This represented, according to Hughes, one of the milestones in the disciplinary transition between nineteenth century botany and twentieth century ecology: from the study of isolated species to the study of plant communities by means such as handmade illustrations, photographs, and maps.

These points are stressed in Chapter 3, the longest one, where Hughes examines the contribution of visual practices in developing a scientific community of ecologists. Ecology pioneers like Robert Smith and Arthur Tansley considered it important to develop visual field methods to communicate the basic concepts and legitimacy of vegetation as an object for scientific study. In my opinion, in this chapter Hughes combines in an exemplary way his historical sources with a sophisticated analysis of the social life of photography in the constitution of ecology as a new science. This is without any doubt one of the biggest contributions of the book: a broad and refined understanding of visual practices that can be used in differ-

ent ways for studying the historical trajectories of sciences. As Hughes analyzes it, ecologists exchanged, collected and transformed photos depending on their use and circulation. For example, photos were used to illustrate lectures and communicate ecological concepts, but also to share experiences of field-collecting in presentations, or to document methods used in studies and broadly to create the occasions among ecologists for thinking, discussing, and contesting knowledge about vegetation. In one of the most interesting passages in the book, Hughes shows how photography was important in the excursions of scientific associations to document their activities, which helped botanists participating in these excursions to start *seeing themselves as ecologists* (p. 155).

But not everything in the study of vegetation was straightforward, and photography was not a panacea to unveil vegetation and make it a knowledge object. According to Hughes, many botanists would resist the view of studying vegetation in favor of species studies by the late nineteenth century (p. 197). So, rather than representations of vegetation, photographs were, following Hughes, the means for ecologists to talk and discuss about their studies of plant associations, so they were not used at face value as direct representations of vegetation. That's what Hughes argues in Chapter 4, where he emphasizes the special devotion of ecologists in developing their visual practices. Print publication would be the preferred visual medium for ecologists to communicate their approach to understanding vegetation and plant associations, especially by creating new journals and textbooks. Interestingly, as Hughes' historical analysis shows, the photographic efforts of ecologists did not rely on a unified understanding of how to translate vegetation into pictures. For that reason, the main significance of photography for ecologists at that time was to show ecological work in action. It is, as made *in the field* through the direct study of plants growing together as a complex phenomenon that deserved scientific attention by visual means.

Maintaining its historical orientation, Chapter 5 delves into the practicalities through which "the field" as the privileged place of knowledge production for ecologists was configured. This is perhaps the chapter that could be more interesting for STS readers looking for new directions in the study of images in scientific practices. Rather than focusing on photographs as devices for creating more convincing and persuasive scientific representations of vegetation, Hughes contributes to opening other analytical concerns that investigate the subjective and embodied foundations of ecological knowledge through photography. Taking the case of the use of maps and cameras in early twentieth-century ecology, the author analyses how the knowledge objects of ecology were negotiated through the body movements and observations of field ecologists studying vegetation. In that way, maps and photographs were configured as "prosthetic technologies of affect" (p. 286), which following the author, could record the embodied experiences of ecologists surveying vegetation. This activity basically consisted of choosing and going to a place "in the field" and judging which aspects of its vegetation deserved to be observed and recorded. In short, maps and cameras were central for ecologists to negotiate their embodied activities when observing plants. The use of these artefacts helped ecologists to configure what Hughes calls a "shared visual cognition" (p. 303) which was practiced in the field and facilitated ecologists' aspiration to reach a common understanding of vegetation's nature.

However, this shared visual cognition was shaped by the very material practices of Victorian and Edwardian natural history in which the act of collecting objects, in this case specimens, was

considered synonymous with knowledge acquisition according to Hughes. In relation to this context, Chapter 6 explores the common practices of photographic exchanges between ecologists, in which they shared similar assumptions of photographs' capacities for structuring and communicating ecological knowledge. This chapter is a bit more ambitious because the author argues that not only for ecology but also for natural history, the mediation of photography was common in its role of expressing the embodied experience carried out in fieldwork practices. So, photography besides being used as a visual witnessing tool to share with others what was seen in the field, was used as well to attest the bodily and affective experience of being "in the field". One of the examples provided in the book is the work of Arthur Tansley in the 1930s, whose field practices of notetaking, photography and cartographic sketching were informed by a particular way of walking and working in the field. In this case, according to Hughes, photographs functioned first, as evidence for the ecological knowledge object and second, as a surrogate for the sensory registration of seeing a woodland plant community. In short, photography was both the expression and vehicle for the embodied knowledge-making practices of ecology.

Picturing Ecology demonstrates the importance and value of archive-led research and the potential of photographic history as a tool to study the formation of scientific discourses and practices. It represents a new appreciation of archival work and photographic repositories contribution to a visual history of ecology, just like Susan Leigh Star and James Griesemer (1989) did it in the past studying animal repositories and their role for research in natural history museums. Hughes offers us a rich historical study which besides making a visual history of ecology, serves as a guide to anyone interested in analyzing the role played by photography in the history of sciences. The book may be useful for anyone in STS wishing to understand the histories, visual cultures and ordinary practices that have shaped the use of photographs in scientific practices.

For some STS readers, Hughes' approach is close to ontological approaches founded on the practical analysis of how the reality of entities, like for example vegetation, is sustained by the activities of people, technologies and other than humans. However, Hughes seems to reduce ontological reflections to discussions about what photography and photographs actually are (pp.14, 36, 287, 422). In my opinion, this is a limitation imposed by the static way that ontology is often understood in photography studies and that could prevent dialogues with many of the ontologically inflected STS contributions that are absent in the book. For some in STS (Ashmore 2005; Mol 2002; Woolgar and Lezaun 2013), ontology refers to the practical and sociomaterial arrangements that sustain and make possible the maintenance of knowledge and scientific objects. For that reason, I think it becomes necessary in future research to develop the conceptual nuances able to connect the historical and cultural importance of photography in the sciences, as argued by Hughes, with an STS ontological understanding of photography where what counts both as images and the possibilities of their use are shaped in practical action. This book will certainly inspire future works in that direction, since it brilliantly opens the doors for further studies that for example could analyze the visual and embodied basis of contemporary ecology, especially in the era of remote sensing, where huge volumes of data and their visualization in maps has contributed to our understanding, sense of action and agency in an epoch of pressing and existential ecological issues for life on earth.

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Making Kin. Fare parentele, non popolazioni [*Making Kin Not Population: Reconceiving Generations*]

by Angela Balzano, Antonia Anna Ferrante and Federica Timeto (eds.) (2022) Bologna, DeriveApprodi, pp. 240 [Italian translation and editing].
by Adele Clarke and Donna Haraway (eds.) (2018) Cambridge, Prickly Paradigm Press, pp. 209.

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I am sitting in the company of my notebook with *Making Kin Not Population*, edited by Adele Clarke and Donna Haraway on one side and *Making Kin. Fare parentele, non popolazioni* – the Italian translation edited by Angela Balzano, Antonia Ferrante and Federica Timeto – on the other. In this more-than-human gathering, I silently admire these two shining examples of collegial debate and respectful disagreement joining together in an antiracist, anticolonial, feminist polyphony. The conversation that I "heard" while reading the books makes my task particularly challenging. The result may be situated between a book review and an act of academic activism echoing these two books. Although the second book is the translation of the first, it is not just that: this translation is a political act and I want to honor it as such, along with its source of inspiration. If scholars – at least in Science and Technology Studies – agree that objects agentially *affect* us "humans", this certainly applies to my relationship with these books that affect me deeply as a feminist scholar, as a heterosexual, white, middle-aged and relatively privileged migrant woman, and – relevant enough to say in relation to these books – as a mother of two. While presenting the book by Clarke and Haraway, in the following I link it to Balzano, Ferrante, and Timeto's book and specifically to their Afterword (pp. 183-196) where they frame their translation and act of translating. Indeed, the Afterword is the only chapter in the Italian translation of Clarke and Haraway's book where Balzano, Ferrante and Timeto's voices emerge.

Critical and appreciative reviews have been already published on Clarke and Haraway's work (for example Appleton and Glabau 2022; Dow and Lamoreaux 2020; Strathern et al. 2019), which includes – along with an Introduction by Clarke – five essays by scholars based in North America (Ruha Benjamin, Donna Haraway, Michelle Murphy, Kim TallBear) and one by two coauthors based in Taiwan (Yu-Ling Huang and Chia-Ling Wu). The volume addresses a North American audience by entwining the contributions around five major categories – feminism, reproduction, population, environment, and kin. "Population" and "kin" are given prominence, both in the original title and in its Italian translation, which – in the subtitle – purposefully uses the plural "popolazioni" ("populations") to stress the plurality of

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human and nonhuman beings to make kin with. "Making" is equally crucial to appreciating the book. As Balzano, Ferrante, and Timeto highlight in their Afterword, generative intersections require a "doing", or, rather a "making" through caring practices across species (hence, the environmental theme) rather than the exclusive generation of new life (i.e., reproduction). Banu Subramaniam (2018) brilliantly summarize that *Making Kin Not Population*:

> resurrects overpopulation as a question for feminism [...] Clarke and Haraway make clear that the solution is not about controlling women but promoting the idea of kin. Feminists, they argue, should promote a world where we make family through lateral networks of friendship and community of nonbiologically related individuals (i.e., kin), rather than increase the global population numbers by promoting traditional families based on biologically related offspring through reproduction (i.e., population).

The authors of Clarke and Haraway's book – who all have been involved and implicated in issues of intimacy and kinship for decades – do not discuss them homogeneously, but differently embed their feminist activism into engaged political analyses of controversial topics. What keeps these authors united is the belief that "population control strategies and policies are by definition anti-woman hence anti-feminist, and that reproductive justice, environmental degradation and climate change are urgent *feminist* issues" (p. 34, *italics in the original*). In this book, the authors offer vital proposals to reconceive generations – as the English subtitle reads.

In the Introduction, Adele Clarke provides some background to appreciate the "intervention" (p. 1) – as she calls *Making Kin Not Population*. In this regard, to my surprise, Balzano, Ferrante, and Timeto paraphrase "intervention" with a more didactic incipit (in Italian "Il tema centrale..."), which, in my view, weakens the militant ethos of the original incipit. In fact, Balzano, Ferrante, and Timeto's overall gesture *is* political, and it is itself an *intervention* addressing an Italian audience at a time of ecological, social, and global crises and, moreover, when the pro-life and pro-family rightwing Giorgia Meloni government took office. Let me come back to this later. Clarke explains that the booklet was born from the intention to provide a collaborative response to the "blooming silence" of feminist STS on the urgent need to reduce "*the human burden on earth while strengthening ecojustice for people and other critters as means and not just ends*" (p. 4; *italics in the original*). These words first appeared in Clarke and Haraway's abstract for a session held at the 2015 meetings of the Society for Social Studies of Science. The session attracted two hundred people and motivated Clarke and Haraway to pursue this book by inviting other brilliant scholars to join.

Ruha Benjamin, in *Black AfterLives Matter: Cultivating Kinfulness as Reproductive Justice* (Chapter 1), examines the relationship between race, reproduction, kinship and feminist imaginaries, and elaborates on the idea of "kinfulness" as reproductive justice. Although subordination, subjugation, subaltern relations and racialization cannot be disjoined from the idea of Black Afterlives, Benjamin points out that there is much more than that; "there is a lot happening underground. Not only coffins, but seeds, roots and rhizomes" (p. 47). Afterlives of past generations sustain future lives by enacting a practice of making kin "*beyond* biological relatives, but also *with* the materially dead/spiritually alive ancestors in our midst" (p. 48, *italics in the original*). In their Afterword, Balzano, Ferrante, and Timeto make us aware of

the care they put into translating words like "black" and "blackness" (they use "ner*" and "nerezza") and "of color" (translated with "di colore"), while keeping in English the word "brown" in consideration – as they explain – of what literature says on the matter and in order to generate "a [political] space and language the Italian speaking racialized subjectivities can identify with" (p. 188, *my translation*).

Donna Haraway's *Making Kin in the Chthulucene: Reproducing Multispecies Justice* (Chapter 2) is "a plea for other-than-biogenetic kindred" (p. 69) that she articulates not without pain caused by the unjust "state-race-sex-resource-colony-and-capital-making apparatuses of counting and inventorying" (p. 70). Her chapter is inhabited by two "populations": *the Born* – the "multi-billions of human beings, industrial food animals, and companion pets enterprised up to mega consumer status" (p. 35) – and *the Disappeared* – the literally disappeared, extinct, invisible, murdered or never-conceived, unborn beings – who, however, *are* a matter of reproductive justice and freedom. Haraway situates them at a time she calls "Chthulucene," which requires sym-poiesis, or making-with or becoming-with, rather than auto-poiesis or self-making through the appropriation of everything as a resource. Such a view is common to the best scientific knowledge practices "foregrounding relationalities and not individual or massed countables" (p. 84). Resonating with Haraway's discussion of the trouble with counting, Balzano, Ferrante, and Timeto in their Afterword point out the difference between the transitive and intransitive Italian verb "contare", translatable as "counting" (transitive) and "mattering" (intransitive): *counting* (in the sense of inventorying) is always a political practice of including and excluding or making some bodies *matter* and others not (in the general sense of being significant, valued, and important). Karen Barad (2007) – who is not mobilized by any of the authors – would refer to the practice of cutting together/apart to describe the differentiated mattering of the bodies as an inevitable consequence of practices of counting life/bodies. We may also recall the foundational STS work of Bowker and Star (2000) on the practice of classification and its consequences.

In *Against Population, Towards Alterlife* (Chapter 3), Michelle Murphy has a different use of the word "population" compared to Haraway's and Clarke's use. While the latter two are committed to population as a central problem associated with the growing human numbers, Murphy "takes a position against population as a framework for a feminist politics while still elevating the question of reproductive politics in feminist decolonial environmental justice" (p. 101). She reminds us that "population as a concept is enmeshed in the very infrastructures and logics that have produced ubiquitous environmental violence" (p. 106). Instead, she brings "reproductive justice" to the center to sustain community beyond biology. Her rejection of the concept "population" – as highlighted by Balzano, Ferrante, and Timeto in their Afterword – allows her to avoid colluding with capitalism, colonialism, white supremacy and heteropatriarchy. Far from a mere critic, Murphy opens a critical path "for a politics of differently distributed futures" (p. 111). She proposes the concept of "*alterlife* – the struggle to exist again but *differently* when already in conflicted, damaging and deadly conditions, a state of already having been altered, of already being in the aftermath, and yet persisting" (p. 113, *italics in the original*).

Yu-Ling Huang and Chia-Ling Wu, in *New Feminist Biopolitics in Ultra-low-fertility East Asia* (Chapter 4), talk of innovative living possibilities supporting nonbiologically related people, for example, in intergenerational relationships. Huang and Wu remind us that "[f]eminist

STS perspectives center the importance of investigating technoscience to untangle *biopolitics*" (p. 128, *emphasis mine*) which have materialized, for example, in the intrauterine devices in Taiwan and South Korea, abortion in Japan, or sterilization in China. In their Afterword, Balzano, Ferrante, and Timeto highlight that those are necropolitical dispositives. In contemporary critical theory, biopolitics and necropolitics are two sides of the same coin, allowing us to analyze power relations and examine the inextricable politics of life and death. To biopolitics and necropolitics, Huang and Wu oppose practices of remaking demography by integrating concerns about the environment, reconceptualizing aging and intergenerational relationships, and taking gender into account in the very conceptualization of the population crisis.

Making Love and Relations Beyond Settler Sex and Family by Kim TallBear (Chapter 5) explores traditional conceptions of family through the affective dimensions of love and familial relations amid settler colonialism. Settler sexuality and family constructs have made both land and humans – women, children, and lovers, for example – into property. TallBear urges an alternative to the monogamist, heteronormative, marriage-focused, nuclear family ideal that, in the U.S., disciplined Indigenous and queer people. A strategy for making kin otherwise relies on thinking relationally about sexuality as a relational power exchange. In their Afterword, Balzano, Ferrante, and Timeto help us see TallBear's invitation to queer intimate relationships as a call to exercise our imagination and vision toward caring relationships other than normative models of kinship ties and obligations. Allow me to link TallBear's contribution to the Italian context – the same that Balzano, Ferrante, and Timeto address in translating the book. I am writing this book review just after the premature passing of the Sardinian writer, playwright, blogger, commentator and literary critic Michela Murgia. She bravely and wisely turned her disease, and eventually her death, into a political situation to create a public debate on queering the traditional idea of family and sexuality. She strongly believed in the right of the "will" (in Latin: *Ius Voluntatis*) or "making kin" according to the principle of free choice. In Murgia's life, such an ethos found its maximum expression in building and making public her queer family with those she called her own "soul children" (from the Sardinian "fillus/as de ànima"; see Murgia's novel *Accabadora*) to describe those whom she – as a "soul mother" – helped to accompany on their journey towards adulthood regardless of any biological bonds but, rather, based on a sincere desire to grow up together. Among others, Murgia's queer family included her dearest friend married "*in articulo mortis*" (that is, "at the point of death") due to the fact that the Italian legal system lacks a formal acknowledgement of queer bonds as sufficient to legitimize the "family" status. She married him as a trusted person to delegate decisions if needed at the point of death. In my reading of TallBear's proposals, I found a resemblance to Murgia's open family, made up of people linked together not necessarily by blood ties. Much more could be said but I refer the readers to the books I am reviewing, including Murgia's novel (2012[2009]).

To conclude, translating is (always) to betray and – luckily! – Balzano, Ferrante, and Timeto did no less. They fully honored the depth and linguistic complexity of Clarke and Haraway's edited book while, in the Afterword, they turned Clarke and Haraway's "intervention" into a political gesture of their own. They did so by articulating their own positioning in relation to the book, its translation, the broader literature on the subject matter and the Italian context. As we understand by reading these final pages, they share with all authors of *Making*

Kin Not Population a feminist intellectual activism that the Italian audience could recognize at the meeting *Making Kin. Reproductive Justice is Eco-justice*, held on October 28, 2022, at the Ca' Foscari Theater. This event, sponsored by the New Institute Centre for Environmental Humanities, brought Ferrante and Timeto (Balzano was not present) in conversation with Adele Clarke and Donna Haraway, who attended online. On that occasion, the Italian authors brought the book down to the national political scenario and took an explicit position against the Meloni government actions (Undisciplined Environments, 2022).

If anything, I would have loved to listen to Balzano's, Ferrante's, and Timeto's voices more in the book, for example with an Introduction contextualizing the translation of the book and enhancing its connection with Italian literature and research. It would have been another way to make kin in an academic landscape deeply in need of thinking otherwise and letting its seeds, roots, and rhizomes flourish.

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Faire sans, faire avec moins: Les nouveaux horizons de l'innovation [*Doing Without, Doing With Less: The New Horizons of Innovation*]

by Frédéric Goulet and Dominique Vinck (eds.) (2022) Paris, Presses des Mines, pp. 252.

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Faire sans, faire avec moins explores the phenomenon of innovation-through-substraction (*innovation par retrait*), a term that describes the process through which actors attempt to reduce or remove problematic entities from a sociotechnical system. Here, substraction is not merely a matter of not using an entity anymore. Rather, it is a call for political mobilisation, technical alternatives, legislative actions, cooperation between actors, and the reconfiguration of all relevant chains of association. Innovation-through-substraction is a challenging process that rarely succeeds. As the editors note, examples showing how subtraction can fail are quite common. Chemicals identified as dangerous by European Union (EU) agencies continue to be widely used and commercialized across Europe, pharmaceutical drugs remain available in the midst of controversies about their side effects, and attempts to halve pesticide use in France have only managed to slow its increase.

The book is a collection of case studies conducted in various countries (including France, Switzerland, Canada, the United States, Argentine, and Brazil) gathered by Frédéric Goulet and Dominique Vinck. The editors are also the co-authors of the paper that, already a decade ago, popularized the theoretical framework for innovation-through-substraction (Goulet and Vinck 2012). Each of the thirteen chapters expands on Goulet and Vinck's argument, which was based on a study of farmers' attempts to avoid plowing, a time-consuming and costly practice that exacerbates soil erosion, and to develop alternative agricultural techniques. The innovation-through-substraction framework proposes to enrich innovation studies by de-centring classical narratives of innovation as the introduction of a new technology (Godin et al. 2021). Shifting the priorities set by Schumpeterian definitions of innovation, it contends with the "destruction" rather than the "creation" aspect of the process. Goulet and Vinck's framework is in line with STS' historical focus on innovation as a process that involves tweaking, re-using and abandoning aspects of new as well as existing technology, as in Akrich's case study of the adaptation of a wood waste compacting machine from Sweden to Nicaragua (1989). Innovation-through-substraction also shares Actor-Network Theory's interest in assemblages (Akrich et al. 2006), but with a focus on the detachments and disentanglements of actants. This "sociology of detachment" pays close attention to the problematization of an

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actant, which in turn brings to the fore entities and associations that were previously unseen. As new entities enter the assemblage to compensate for the exclusion of the problematic actant, they trigger a reorganization of entities within the assemblage.

The book's ambition is to develop and systematize the editors' 2012 theoretical proposal by testing it against varied case studies. The book therefore takes part in the ongoing discussion about the uses of innovation as a concept, a narrative and a socio-technical imaginary (Godin et al. 2021). Thematically, the book also significantly engages with the growing field of agri-food studies in STS (Creager and Gaudillière 2021). In the introduction, the editors identify several fields in which innovation-through-substraction is already an object of study. Conceptually, besides engagements with STS and innovation studies, their framework resonates with *transition studies*, particularly the literature on ecological transitions, and the studies of frugal innovation (Geels 2002). Yet Goulet and Vinck argue that there is a need for a framework that specifically and fully engages with the substraction process, its implications and its challenges. The focus on substraction, rather than frugality, brings into view the paradoxical additions that are necessary for substraction to happen: developing alternative technology, adding new actors into the network, and making problematic substances newly visible.

The editors of *Faire sans, faire avec moins* are both sociologists of agriculture. This disciplinary approach is also reflected in the book's contributions. Most of the chapters concern food: how we produce it, prepare it, eat it, and most crucially, why we remove some food from our diets and how. Case studies explore what it means not to eat gluten (Ch. 3) or meat (Ch. 4), to reduce the use of pesticides in crop farming (Ch. 7) or antibiotics in livestock farming (Ch. 8), to set up food-to-cafeteria circuits (Ch. 9) or decentralized agricultural data collection systems (Ch. 10), and to get rid of food packaging (Ch. 11). The book also broaches other topics, such as vaccine hesitancy (Ch. 6) and pharmaceutical drug withdrawal (Ch. 13) , electricity non-consumption (Ch. 5), and regulations about chemical substances in industrial production (Ch. 12). It also offers more theoretical perspectives, including a historical analysis of the concept of innovation (Ch. 1) and a reflection on systemic disruption (Ch. 2).

Six themes return throughout the book's chapters. First, the phenomenon of innovation-through-substraction relies on a powerful narrative that calls for the return to a simpler and often more natural way of life. The push for getting rid of a substance or a practice is not only a collective negotiation of the acceptable level of risk. It draws on hopes for a better future, a "promise of difference" (p. 143) that would grant people more freedom, a simpler life, and a closer connection with nature. Several chapters illustrate that these hopes are bound to be disappointed, as substraction almost always implies the establishment of an alternative as well as new mediations to sustain it. In a word, things rarely ever get simpler or more natural: whenever an actor is taken away from the assemblage, one or several others are introduced in its place in order to stabilize the sociotechnical system as a whole. Yet the narrative endures and finds its roots in a historical condemnation of innovation(-through-addition) as a dangerous challenge to the natural order of things (Ch. 1).

Second, the substraction of an entity results from an active and prolonged mobilisation on the part of concerned groups and institutions. The identification of a substance or a technology as dangerous or even deadly is not enough to prompt its withdrawal. The continued use of Di(2-ethylhexyl)phthalate (DEHP), a chemical used in plastic goods, within the EU is a

striking case (Ch. 12). While the EU's institutions instances have acknowledged the dangerosity of DEHP, industrial firms manage to circumvent the EU Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), taking advantage of the joint submission process (which lets several companies present a shared application for the authorization of a molecule) and substituting dangerous molecules with similar substances that have not (yet) been examined and banned under REACH. In sum, for a substraction to happen, a crisis is not enough. Existing sociotechnical systems are solidly locked into place, and the process of withdrawal has to be organized and governed in the long run to succeed (Ch. 2).

Third, innovation-through-substraction can paradoxically stabilize, rather than change, a sociotechnical system. Substraction can be a way of "changing everything to ensure that nothing changes" (p. 37) by removing the problematic entity before it endangers the system as a whole. Pharmaceutical firms use withdrawal as a loss management strategy when sales are low or when a drug becomes embroiled in a controversy, evading more fundamental critiques about the industry as a whole (Ch. 13). The trajectory of appetite suppressants in West Germany between the 1960s and the 1980s illustrates this process. A scandal about the drug's dangerous side effects led to a withdrawal of the medication, changes in its composition, and a reintroduction on the market under the same name. There would be two more scandals and two more cycles of withdrawal and reintroduction over the next two decades. This highlights the stability of sociotechnical systems as well as the importance of the substitution process in the conduct of innovation-through-substraction.

Fourth, and this is at the heart of the book's theoretical proposal, innovation-through-substraction is as much about bringing new entities into the system and creating new relationships as it is about excluding actants and undoing attachments. Efforts to minimize the use of antibiotics in livestock farming are typical in this regard (Ch. 8). Depending on the sector (poultry, pigs, dairy cows), the diminution of antibiotics use depends on the introduction of new entities and practices: reorganizing the barn's space, keeping a closer watch on early symptoms of disease in animals, using aromatherapy and homeopathy, etc. In some sectors, the process intensifies farmers' involvement in large agribusiness conglomerates that oversee "antibiotics-free" labels, and in others, farmers enter new networks organized around local peer groups and alternative farming techniques. The (partial) substraction of antibiotics therefore has very different implications for farmers, particularly in terms of network reconfiguration. As for the creation of farm-to-cafeteria circuits, in which institutions that oversee school cafeterias and other canteens attempt to switch to locally-produced food, it produces "quasi-detachments" rather than revolutions (Ch. 9). The proximity of farmers willing to sell their products and cafeteria managers willing to buy them is not enough to ensure a transition to locally-produced food. To account for numerous constraints, such as regulation about food safety or farmers' refusal to deal directly with clients, assemblages bring together old and new entities and mediators.

Fifth, innovation-through-substraction is at its core a matter of making certain entities visible and others invisible. The problematization of an entity, designated as dangerous and intolerable, brings to light the functions it fulfills and the relationships it maintains with the rest of the assemblage. The history of food sale and specifically of food packaging provides an illustration of this aspect of innovation-through-substraction. In France, where the rise of the supermarket and pre-packaged food throughout the second half of the 20th century has du-

rably shaped market mediations, the return of bulk selling brings to light the work performed by food packaging (Ch. 10). To make up for the absence of packaging, consumers have to self-serve and portion the food they buy, bring their own reusable packaging, wash it between two store runs, and collect the nutritional and origin information that is usually displayed on the packaging. By substracting prepackaging as well as salespeople, the modern bulk store makes their work visible to the consumer, to whom it is handed down.

Finally, innovation-through-substraction relies on the construction of categories. The delineation between entities that are problematic, still-acceptable, and virtuous alternatives is a typical exercise in political debate under the guise of technical planning. A comparison of France, Brazil and Argentina on pesticide reduction policies illustrates that the same entity can be problematized, defined, and categorized very differently depending on the actors involved in its withdrawal (Ch. 7). In Brazil and Argentina, the preoccupation with pesticides is driven by export requirements and productivity gains. This leads to the simultaneous use of natural and chemical pesticides as well as intensive biotech research, leading to the creation of the "bio-intrant" category. In France, the State's ambition to curb pesticide use and tense negotiations with agricultural actors has inspired the "biocontrol" category, which includes chemicals that are classified as both not synthetic and not dangerous for the environment.

Faire sans, faire avec moins successfully meets the challenge of expanding the framework of innovation-through-substraction, significantly enriching its initial expression. In this instance, the format of the case studies collection works well, as it allows the reader to confront a ambitious theoretical frame with studies that test its limits and supplement its intuitions. The case studies and their diversity are a strength of the book, but also a challenge for readers who have to grapple with multiple and diverse topics that are sometimes very succintly described. Nonetheless, each chapter contributes to the overall argument of the book, and many are excellent STS case studies in their own right, with original concepts, thought-provoking fieldwork, and a critical distance with the normative stances encountered in the field. There is, perhaps, one area that calls for further research: the experience of users and consumers with innovation-through-substraction. Some chapters engage with the topic, particularly Chapter 3 on the trajectories of individuals with gluten-free diets. Nevertheless, an additional focus on users, their cooperation and resistance to substraction processes, their own bricolages to substract problematic entities, or their alternatives to the "official" alternative would further enrich the framework of innovation-through-substraction.

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Digital Oil: Machineries of Knowing

by Eric Monteiro (2022) Cambridge (MA), The MIT Press, pp. 215.

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In the last decade, "data is the new oil" was a metaphor commonly used to demonstrate the economic significance of data. Labeling data as "the new oil", was a way of expressing how data is now considered to be the most valuable asset, just like petrol once was. Empires were built over it, and tech companies are now more valuable than petrol companies once were, as demonstrated by the European Parliament briefing "Is data the new oil?" (Marcin Szczepański 2020). Eric Monteiro draws on this metaphor, exploring the digital transformations in offshore oil and gas work practices, and delving into obstacles faced by digitalization. What is distinctive about Monteiro's approach is the use of the metaphor "data is the new oil", to analyze the Norwegian offshore oil industry – which has been through an intense process of digitalization – as a backdrop to discuss datafication in a broader landscape.

The author, who is located at the Norwegian University of Science and Technology in Trondheim, chose a relevant topic in Norway – the industry of commercial oil and gas – to explore practices, roles, and organizational decisions in the field throughout the evolution of technology, highlighting how societal and political decisions have shaped the process. The goal of the author is not to feed the divide between early or predigital practices of offshore oil exploration and recent forms of digitalization but to advocate that the adoption of technology is part of an evolutionary, small-step movement and that digital representations are as real as the physical in the material of knowledge and that oil and digital oil is a suitable example of this affirmation.

Digital Oil: Machineries of Knowing is divided into three parts, in which the eight chapters of the book explore all the phases of commercial oil activities, taking place as follows. In Chapter 1, the *Introduction*, the author centers the narrative of the book on the context of the Norwegian continental shelf with the North Sea and the Barents Sea, where offshore gas and oil reservoirs reside over one to five kilometers below the seabed. The chapter offers the reader a historical outline of the political and institutional process that has shaped Norway's oil and gas industry.

The first part of the book, Chapters 2 and 3, work as the backdrop of the subsequent parts, outlining the historical conditions of Norway's fifty years of oil exploration, and the further digitalization of oil, a process that was initiated around the 1980s and early 1990s and that has significantly transformed since then. Throughout Chapter 2, named *Context*, it is possible to observe how the political choice of recognizing oil resources as a public good and the impor-

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tance of learning by doing was essential to place Norway as one of the leaders of commercial oil and gas activities. Initially, the political choice was to maintain control over oil handling to national companies and to gradually open the market to international competition, a process that allowed Norwegian companies to be competitive with major international companies but also control not only its oil but also the data later extracted from it. Demonstrating how the process of digitalization and generation of data is highly influenced by technical, economic, ethical, and political factors, as highlighted by Rob Kitchin (2014b; 2021).

Chapter 3, *Apparatus*, focuses on the different technological developments and adaptations across all phases of Norwegian oil activities. Throughout the chapter, the author enlightens that each phase of oil activity – such as exploration, drilling, production, and logging – is measured by different instruments, with different purposes, generating different data with different quality. The volume of data is considerable, which also results in several issues such as the veracity of data that might be under question due to noise and the calibration of sensors. This process of constant adaptation to collect data despite the adversities posed by the specific phase of oil drilling is the perfect example of the point made by Rob Kitchin (2014b). Data is not a single homogeneous concept, instead, data is partial, selective, and aimed at drawing conclusions from a specific environment, which in this case corresponds to each phase of the oil drilling activity. At the same time, the example brought by Monteiro fits to explain common issues faced by many other areas that depend on data collection, since its concerns with data quality, the volume of data, and the need for constant adaptations are present. Thus, although data is not a single homogeneous concept, the obstacles faced by the Norwegian oil industry when collecting oil data are also faced in data collection in other areas, bridging the gap between the metaphor "data is the new oil" and the "oil data".

In the second part of the book, Monteiro focuses on empirical studies which mirror the phases of commercial oil activities. Initiated with Chapter 4 titled *Data*, the author explores the process of "cooking data" – as coined by Rob Kitchin (2014a, 5) – or "crafting data" (as Monteiro refers on p. 75), through algorithmic cleaning and repairing. To do so, Monteiro delves into the work of "data managers" who are multidisciplinary professionals who work at different organizational units of Norwegian Oil production and are responsible for grasping different datasets of historical geodata with different formats, patching them together. Their work holds value due to their knowledge of going through data noises – such as seismic data – and knowing what data to trust and to disregard, an essential task for the corporate quality system. The role of data managers sheds light on the process of datafication described by Jose van Dijck (2014), which is characterized by the process of quantification and digitalization of all human activity. While data managers are essential to the corporate quality system due to their knowledge of historical seismic data, their jobs are vulnerable due to the potential for automation, a process which is again a metaphor for the current process of datafication that occurs outside the world of oil mining and embraces many professions.

Chapter 5, named *Uncertainty*, focuses on the work of geoscientists and geophysics along oil exploration, which is an essential and strategic phase for global oil operators that is full of uncertainties with a hit-rate of 5%, (p. 89) but representing 10 to 20% of total investments for an upstream oil operator. The task of digitalizing a highly uncertain activity seems contradictory in a world that often takes data as the ultimate source of truth and makes decisions based

on them. However, as Rob Kitchin has pointed out, data analysis must take into consideration the issues of representativeness, error, bias, and uncertainty that come (2014b). Thus, in reality, data collection in all sectors requires attention due to technical and ethical considerations often ignored, and therefore causing bias, injustices, violation of rights, and unethical behaviors. And just like the work of "explorationists" – a concept created by Monteiro to refer to geologists and geophysicists that feed the data that data managers will eventually analyze – must balance these considerations with corporate necessities, other professionals in other areas also face the same dilemma, with often deeper consequences such as dataveillance as pointed out by Jose van Dijck (2014).

Chapter 6, titled *Knowing*, inaugurates the section of the book that covers the development of oil production and addresses the issues coming with the process, especially sand. Sand monitoring is an essential process in offshore gas and oil explorations since it reduces the plant's processing capacities and oil quality. At the same time, sand is used by Monteiro to discuss other types of "data dirt" – lack of quality data – present in other areas of data collection and discuss how operators know and act upon these challenges and what mitigating actions are taken. To make this analysis, the author conducted interviews in which he observed how engineers navigate and interpret "real sand" – the dirt that comes out of the ocean's soil – and "digital sand" – errors that real sand causes to the IoT sensors and to the data their collect. He highlights that although real sand can be digitally represented and sand-monitoring routines are put in place to address related issues, this digital representation carries little value if there is no accompanying company infrastructure, practices, and technologies. This analysis brings back the discussion raised by Rob Kitchin (2014b) related to the ethical and technical issues with data. Issues such as bias, injustices, and violations of rights can be digitally represented in datasets, yet if the ones that are using the collected data do not adapt their infrastructure, practices, and technologies to address these issues, this digital representation holds little value.

The following Chapter 7, *Politics*, explores the political discussion behind oil exploration, which was responsible for financing the Norwegian welfare state but also its repercussions on data control and collection in the country. This section ties back with Chapters 2 and 3, which outlined the political process of oil exploration in Norway to explore how digitalization – of oil but also of any other world aspect – is complex and nuanced with political choices which might affect the quality of data and who has access to it. In Norway, the political process of oil exploration and later digitalization was essential to make the oil data a public good and finance the Norwegian welfare. In other countries, such as the United States, the process of privatization of oil drilling was essential to put data in the control of the private sector and eventually further the divide between the private and the public sector. Through this analysis, the author connects directly with Rob Kitchin (2014b) and Lisa Gitelman (2013) who argue that data is not simply data, but instead, a process that is conceived and nuanced depending on those who capture, analyze, and draw conclusions from them, and that data is not "raw", but a cultural resource that is socially interpreted and shaped.

In this context of social interpretation and shaping of data, the author explores datafication of the marine environment through the Venus Project, a project that started in 2005 aiming to test the viability of using IoT in the ocean. While the project did not get much attention initially, political processes and the need for further exploration of oil reserves located in the ocean have raised

attention to it, demonstrating once again how political and financial motivations often influence the collection and interpretation of data. The hard task of quantification of the marine environment, as well as other phenomena such as climate change, has the effect of reducing nuances into metrics, "transforming quality into quantity" (p. 164), eventually influencing the methods of environmental classification to ones that favor a specific political or philosophical thought. Therefore, the environmental complexity of the ocean is transformed into numbers through datafication, and once parameters are put in place, numbers become more acceptable than reality, allowing the exploration of ocean zones that before were excluded from oil exploration.

The third and last section of the book is named *Implications* and consists of the *Conclusion* in Chapter 8. Here, the author elaborates and synthetizes the previous sections, exploring the implications of digitalization moving from oil to the process of datafication of society. Overall, Monteiro takes the readers on a journey that initiates from a very specific context of the Norwegian oil exploration, and its process of datafication but expands to explore how the same obstacles are faced in multiple scenarios that are going through datafication. Taking a provocative route, the author accomplishes the task of demonstrating the interconnections between the tangible and the intangible worlds by emphasizing how organizational and institutional aspects shape how data is collected and processed. Through this process, Monteiro demonstrates how data is a dynamic concept, and how this changeable characteristic impacts how it is perceived and how its results will impact the world.

Hence, the merit of this book, in addition to allowing to learn more about the process of data oil, lies in enabling the comprehension of how the social organization and the institutional fabric shape technological advancements and the consequent expansion of datafication. Through the use of the oil industry as a backdrop, readers can appreciate the interconnections between the "data world" and the "real world" and comprehend how they interact and influence each other. Thus, the interdependent relationship between society, science, and technology is a source of inspiration for STS researchers, who can draw from the innovative angle of this book to enrich their own research.

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Everyday Automation: Experiencing and Anticipating Emerging Technologies

by Sarah Pink, Martin Berg, Deborah Lupton and Minna Ruckenstein (eds.) (2022) Abingdon and New York, Routledge, pp. 250.

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Do you know when you are typing, and your phone tries to guess the subject and suggests the next word? Or when Alexa talks to us and suggests results on a specific topic? These are examples of automation in our daily lives. *Everyday Automation: Experiencing and Anticipating Emerging Technologies*, edited by Sarah Pink, Martin Berg, Deborah Lupton, and Minna Ruckenstein, provides a comprehensive examination of the impact of Artificial Intelligence (AI) and automated decision-making (ADM) on our daily lives. Despite their messy and shifting nature, as outlined by the contributors in this volume, AI and ADM are characterised by algorithms. Therefore, *Everyday Automation* suggests an exploration of the everyday and situated relationships with automation, aiming to humanise it while emphasizing the impact, presence and perceptions related to ADM and AI.

This is an edited volume that puts forward a research agenda structured around an interdisciplinary way of exploring everyday automation. The book dialogues with and expands on contributions from more-than-human theory, Feminist Human-Computer Interaction (HCI) and scholarships tackling the everyday engagements of humans and non-humans with algorithms and digital infrastructures. If Kate Crawford (2021), reviewed in TS 1/2022 by Federico Cugurullo, provided readers with a reflection on the places (earth), practices (labour and classification), forms of knowledge (data), elements (affect) and organizations (state) implicated in the many stages of AI development and implementation, this book proposes a focus on the mundane engagements between humans and AI, presented in the form of ADM. This approach acknowledges the humans involved in every stage of the design, delegation, and implementation of automated systems. Bringing people and their daily practices to the discussion around automation allows striking a balance between industry portrayals of automation as a perfect solution and the view of data-driven decisions as cruel and reductionist. Through this book, the contributors focus on the human part of automation processes and allow us to consider the practical, experiential, social, and political implications of automated technologies in everyday life.

The first part of the book encompasses Chapters 1 to 4 and is named "Challenging dominant narratives of automation". It provides an overview of moments where imaginaries, vi-

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sions and narratives around automation are challenged, echoed, or multiplied by our daily practices. In Chapter 1, Lina Rahm and Anne Kaun analyse newspaper clippings on automation in the Swedish press from the 1950s to 1980s. They examine mundane ways of imagining technological change and the visual depiction of such processes. They reveal how public discourse on innovation and automation oscillates between confirmation and demystification of technology, while simultaneously reinforcing the idea of natural and inevitable technological progress. Sarah Pink, in Chapter 2, discusses the role of trust within industry, policy and research sectors shaped by a techno-solutionist innovation paradigm, as the market of ADM transport mobilities. She shows how the coupling between trust in automation and human ethics disconnects the everyday worlds where ethics and trust are experienced from those where automated technology is designed and developed. Looking at future imaginaries of ADM transport mobilities, trust is situated as something that needs to be generated so that people will (correctly) use automated technologies to solve societal problems. In Chapter 3, Deborah Lupton introduces a sociocultural reading of how digitised surveillance was deployed or anticipated in the year following WHO's pandemic declaration, highlighting the implementation of digitised surveillance in social and political contexts and effects. She anchors the chapter in three concepts: digitalisation, datafication and dataveillance to explore Covid as a calculatory process that despite heavily relaying in surveillance practices and in the implementation of digitised Covid solutions, still had little impact on populations living in data poverty and potentially leading to the exacerbation of existing disadvantages and discriminations. Chapter 4 discusses the implementation of automated attendance systems in classrooms. Neil Selwyn discusses how the implementation of facial recognition technology in Australian schools – part of an automated attendance system – is connected to a broader dominating educational logic that conditions contemporary school reform to disintermediate the interaction between teacher and students, reducing the student's subjectivities to data points and diminishing teachers' capacity to deal with emergent classroom dynamics.

The second part, "Embedding automated systems in the everyday", is composed of Chapters 5 to 9 and focuses on how automation has crept into our more intimate and personal moments and the consequences of this movement. In Chapter 5, Jenny Kennedy and Yolande Strengers propose a gender reading of digital assistants. In their work from 2020, Kennedy and Strengers tackle how digital assistants revisit outdated gender stereotypes (Strengers and Kennedy 2020, reviewed in TS 2/2021 by Linda Paxling). In their contribution to "Everyday Automation", they expand on their previous work by exploring how gender is programmed into these assistants and how their decisions are bound by ADMs seeking to automate distinct manners of care, resembling "women's intuition" or the feminised work historically connected to bearing high levels of emotional intelligence. This specific performance of gender is a way of facilitating the acceptance of caregiving coming from digital assistants or "smart wives". Heather Horst and Sheba Mohammid, in Chapter 6, focused on the Echo Look, an Amazon device that uses AI to collect social media data on clothing and provide people with suggestions and recommendations on outfit options. What the authors highlight is how users make sense of Echo Look practices, the context of its use and the limitations of this machine, that is, what Echo cannot see, like different fashion contents and contexts. Chapter 7, authored by Jakob Svensson, exposes the ways in which people get entangled

with algorithms on a daily basis. He explores how algorithms and algorithmic automation are imagined in a newspaper's newsroom and the socio-institutional practices embedded in these imaginaries. Svensson argues that the way the newsroom staff imagine the algorithm also frames the calculations of the algorithm itself. For example, imaginaries of algorithmic automation as labour-saving and time-efficient afforded the construction of an algorithm responsible for sorting the newspaper's frontpage and which news reach readers. Consequently, the algorithm optimized the journalists' time and allowed them to focus on the content. In Chapter 8, the focus of the analysis lies on office-based workplace tracking devices. In this chapter, Stine Lomborg explores self-tracking at the workplace. Through empirical work in Denmark, he shows us how everyday AI solutions at work try to advance a homogenisation of work values while forgetting that users actively contribute to the uses of technology and continuously shape and reappropriate digital systems to their own ends. The last chapter of this section, written by Magnus Bergquist and Bertil Rolandsson, presents a discussion on the delegation of decision-making to ADM devices in healthcare. In their text, it becomes clear that ADM is an opaque and ambiguous tool which allows workers and professionals to improvise and be creative in managing healthcare, granting healthcare workers the capacity to perform even more complex and nuanced practices.

The third and last part – Chapters 10 to 14 – titled "Experimenting with automation in society" discusses the many different engagements, practices and relations established with automated technologies in the everyday. In Chapter 10, Martin Berg looks at robotic process automation in the workplace and how companies create value propositions in relation to their products and specific ideas about what work is and what it can become. By looking at the discursive practices of two companies – UiPath and Blue Prism –, Berg argues that companies employ a certain vocabulary around change, re-imaginations and transformation that situates and performs work practices as part of an automated future. Julia Velkova, Dick Magnusson and Harald Rohracher examine in Chapter 11 how energy companies and tech start-ups' use ADM systems in smart thermostats and how it impacts the relationships between the privacy of our homes, energy infrastructure providers, and data-driven companies. In this process, ADM becomes a form of mediating algorithmic logic that "binds together, mediates, and transforms relations between multiple economies and 'social worlds' brought together by a common concern with temperature" (p. 172).

Chapter 12 unveils the ghostly presence of prisoners training and creating AI. Tuukka Lehtiniemi and Minna Ruckenstein explore the Finnish company Vainu and how it employs prisoners to perform data labour. In highlighting how the company tries to conceal the subjects that are part of processes of automation, the authors explore how the ghost work of incarcerated bodies, and their invisibility is an integral part of obscuring and occluding the way AI mechanisms are trained. Chapter 13 proposes as a research design an ethnographic approach to dissecting the future of automated mobility solutions and explore how this type of research creates new ways of engaging with the social implications of ADM and the context in which this technology is being deployed. The authors in Chapter 14 provide a way of addressing current ad politics and accountability. If advertisements used to be publicly available to anyone, now they have gone "dark" and are visible only to whom they are targeted. This moves everyday engagements with advertisement away from overarching public

scrutiny, raising a series of concerns about tailored discrimination, predatory advertising, and the circulation of misleading political advertising. The rise of "dark ads" is followed by a concern with their accountability and the authors try to contribute with a methodological way of addressing this through back door access and auditing practices.

Summing up, the book adds value to anyone interested in how our most intimate and mundane routines are structured around automated processes and the possible consequences of this move. It enlarges the chorus of STS scholars demanding a more serious engagement with how AI and other automated processes became part of our everyday lives and how different actors like companies, invisible workers and devices are implicated in our ways of engaging with technology. A potential way of moving this research agenda forward would involve delving into issues that were not extensively examined in "Everyday Automation", such as the environmental costs implicated in the production, use and discard of ADM devices (e.g., Crawford and Joler 2018) and the aesthetic experiences part of everyday engagements with algorithms and AI (e.g., Phan 2019).

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La Servitude électrique: Du rêve de liberté à la prison numérique [*The Electric Servitude: From the Dream of Liberty to the Digital Prison*]

by Gérard Dubey and Alain Gras (2021) Paris, Éditions du Seuil, pp. 370.

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During my participant observation with Ohio's' now-defunct Industrial Pollution Control in 1979, I visited the Conemaugh power plant in western Pennsylvania. There, I saw the generation of electricity destined for New York City over 300 miles to the east, whilst fuel waste and air pollution haunted Pennsylvania's rivers and residents. Earlier I visited as a non-participant to observe Ohio Edison's Edgewater power plant in the northern Ohio city of Lorain. With a dedicated turbine for the generation of electricity solely for Chicago over 300 miles to the west, fuel waste and air pollution impacted Lake Erie's south shore and Ohio residents. Over several decades, residents of Pennsylvania and Ohio suffered the polluting effects of fossil fuels in Conemaugh and Lorain to generate electric power for two major cities over 300 miles away.

The challenge posed by sociologist Gérard Dubey and anthropologist Alain Gras is to view cities as metaphorical parasitic entities siphoning fossil resources for electric power. This visualization of "cables on catenaries" (p. 186) sparked my recall of the above-mentioned cases. I remember my immediate reaction then was that fuel waste and pollution were not innocent by-products of resource extraction and electricity generation, but were driven by economic forces beyond the control of locals. As such, these by-products were an expression of capitalism's structural violence that were too long ignored by regulators.

These 20th century cases are exemplary of the propensity for general populations in industrialised societies to overlook electric power's dependency on these sources. Seeking to understand this persistent social phenomenon, Dubey and Gras offer a unique enquiry into the general public's perception of fossil fuel-generated electricity power.

Criticism of fossil fuel-generated electric power is not new to Science and Technology Studies (STS). Querying the generation of electricity and asking to what extent this production affects our society and planet lies at the core of a realization that technology is seldom neutral, especially in the digital age (see Ekhardt et al. 2017; Gerrie 2018; Timcke 2021). Dubey and Gras nevertheless aver that critical histories of electric power consumption and its attendant environmental and social impacts are not common in sociology, "even less in philosophy" (p. 9). The biggest reason the authors give for this alleged paucity is a general bias for electricity to be seen as green whilst ignoring the massive exploitation of fossil fuels (coal, gas, petroleum)

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to generate it, which discourages a view not wider than partial. Employing the metaphor of magic as an "Electricity Fairy" provides a window to challenge assumptions and allow readers to grasp these technocultural dynamics. Yet, British cultural studies theorist Debra Benita Shaw (2008) already noted that technology often appears to be magical in its operation and application because the development of new technologies increasingly overtakes the ability of lay persons to understand the principles of their functioning. Seeking to unmask the under-theorised "Electricity Fairy" therefore is no easy feat, especially where the race for renewable energy places trust in electricity to save the world.

Consequently, *La Servitude électrique* is an ambitious book in two parts – the first part is a sociocultural survey on electricity and its context of rapid transformations, which is followed by a second part, describing the transformation "from an electric cage to a digital enclosure" (p. 209). The 13 chapters of Part 1 are nearly double the size of Part 2 and are Dubey and Gras's strongest as they set the table for the authors' thesis that the origin of electric energy remains very mysterious and "thus leaves a hint of the supernatural" (p. 10). Hoodwinked observers not only treat electricity as a wonderful means of distributing power, but also as "a self-creating power" (p. 10). Ignoring the attendant "ever-ascending march of the fossil" (p. 16) to generate electric power, green-washing hucksters call it sustainable development.

The seven chapters in the second part explore the electricity fairy's digital progeny and the human problems that result from it. Itself a junior fairy arising from the creation and maintenance of these environments that brutally deplete our planet's resources and gradually renders the Earth effectively uninhabitable, the digital fairy seeks to hoodwink us into self-confinement and the dwindling of direct human interaction. Although the consequences are more tangible in the junior fairy's takeover, the electricity fairy's increasing appetite for fossil fuels nevertheless negatively impacts life on our planet, accompanied by the digital fairy's erosion of individual liberty in societies suffering increasing algorithmic interference. The authors caution the fairies' advances are already leading to putting life and social arrangements under a glass in a kind of "lasting and anxiety-provoking semi-confinement" (p. 209). Invoking Marcus Rafelsberger's 2012 disaster thriller novel "Black-out: Tomorrow will be too late", written under his pen name of Marc Elsberg, the authors illustrate "the extraordinary fragility of a society that not only put all its eggs in one basket' of electric grids, but whose basket is itself only 'a mirage'" (p. 302).

This book is ideal for undergraduate introductory courses in STS. The authors' decision to include illustrations is remarkable, and they complement their well-researched history of electric power and its concealed unsustainability under the guise of a "Green New Deal". Furthermore, the book presents a three-fold "phenomenological" approach, incorporating Tocqueville's law, Bentham's panopticon, and electricity's elusive ability to evade capture, offering readers creative metaphors to engage with the text. The authors explain that French social philosopher Alexis de Tocqueville had affirmed that societies are always affected by the conditions which saw them born. Subsequently, the industrial revolution's choice of fire (fossil fuels) as the preferred means of industrial development ensured the electrical phenomenon does not escape Tocqueville's law. Changes and shifts in certain socioeconomic patterns resulted from this ever-spreading reliance.

Bentham's panopticon is useful to understanding the form of existence dominated by electricity today in terms of a technical macro-system governed by a centralized view of ex-

changes. The authors' last point is that electric current does not allow itself to be imprisoned. Hence the never-ending search for a battery than can do just that. Commendably, the authors proffer no simplistic solutions. Rather, they explain how the sustainability of human life and the planet requires the unmasking of capitalist myths that perpetuate "concealment of the materiality of [electricity's] origin and fuel waste" (p. 14). South African social philosopher Scott Timcke (2021) noted this unmasking project compels us to ask how the purposeful construction of a subject might hide as much as it "might illuminate" (p. 22).

The authors' metaphorical window of electricity as a *magical fairy* is provocative, yet it echoes the materiality concerns of previous critical contributions. For example, Canadian philosopher James Gerrie (2018) noted that it might actually be less polluting to simply burn the original fuel, such as oil in the form of gasoline, in a vehicle itself, "rather than in a power plant" (p. 164). Gerrie explained that if electric cars replaced cars powered by internal combustion across the board, peak loads would significantly increase and this, in turn, would prompt electricity plants to generate much higher levels of electricity simply to cover possible peak loads even when people are not intensively consuming. In short, a substantial amount of electricity generated by fossil fuel dependent power plants would be wasted.

Despite the Epilogue's strong claim that "green electricity will not become a reality" (p. 333), this book offers much more than can be covered in this review. For instance, Max Weber (1978[1921]) introduced a famous and controversial idea about two types of rationality: one based on values (*Gemeinschaft*) and the other on achieving specific ends (*Gesellschaft*). However, in our modern society, we often prioritize a peculiar form of utilitarianism, centred on the freedom to consume. In their collaborative work, social philosopher Felix Ekhardt, social anthropologist Christine Fassert, and sociologist Luigi Pellizzoni pointed out how our economic system continually attracts consumers who buy more and new products, often without considering the production process or societal level (2017, 108). The transformation of formerly magical mysteries into a technological electric servitude ultimately serve *Gesellschaft* aims.

Further, we are reconfiguring our machines to be reproductive rather than productive. Rather than investing in personal solar panels to begin an adventure of home solar energy-generated electricity, many are more interested in whether a touchscreen phone that folds like flip phones did twenty years ago is the next fad; or how many cameras the next iPhone will offer. The authors aver the internet is the epitome of this hyperreality of reproducibility. As a result, an incessant call for growth the GDP arbiter, baptized as progress, defines liberty in economic terms, and "therefore mixes values and ends" (p. 179). As the authors conclude their exploration of the digital electronic condition, "electric magic" (p. 338) takes a very unexpected turn, when the vision of an object-world, reduced to the state of "inert scenery", no longer talks to us (p. 339).

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