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Dis-entangling Futures, Old Age, Border Regimes

Our Lady of Technology Tarot Cards (2021) by Tessa Forshaw, Rich Braden, Ailsa Petrie, and Natasha Bach

For too long, tech has had a (misplaced) reputation that it is by men and for men. We have consistently seen this play out in design thinking classes we teach at the Stanford d.school and Harvard DCE, as well as workshops with clients: women participants regularly remove themselves from conversations about emerging technologies and defer to their male colleagues.

This has consequences for all of us. Excluding voices in the innovation process means that we're not designing products and solutions with all needs in mind. It also means that innovation spaces lack a diversity of perspectives that they sorely need.

Our Lady of Technology Tarots Cards aims to change that.

Drawing on the tradition of tarot, these cards reimagine the 22 Major Arcana to represent the big technology trends that are influencing life as we know it. Each card provides a definition, characteristics, and applications of a specific technology, such as IoT sensors, machine learning, and bioinformatics.

Driven by our observations and conversations with our female students, colleagues and clients, we created the deck as a tool to help women, and any others who have felt excluded from tech conversations. Our aim is to build competency in a space that has long kept a diversity of voices out. We hope that by using this deck, all learners will feel empowered to not just see what the future might look like, but to help prototype and design it too.

You can learn more about them here: https://designawards.core77.com/Visual-Communication/108183/Our-Lady-of-Technology-Tarot-Cards

Photocredit: Ailsa Petrie

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Cover *Our Lady of Technology Tarot Cards* (2021), by Tessa Forshaw, Rich Braden, Ailsa Petrie, and Natasha Bach

Dis-entangling Futures, Old Age, Border Regimes

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Disentangling Futures from a Science and Technology Studies Perspective

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Abstract: In the last decade, science and technology studies have paid increasing attention to the role of futures, anticipatory expectations, and forward-looking statements in co-defining the nexus between science, technology and society. This broad interest is articulated into several research streams, from the assessment of long-term futures of technological innovation and setting out how future-oriented socio-technical imaginaries act upon real-time technoscientific innovation to actionable anticipatory frameworks and scenarios adopted to intervene in science, technology and innovation governance. This paper introduces the special section *Disentangling Features*, which collects four lectures from the teaching and mutual learning activities held during the VI STS Italia Summer School, organised at the University of Padova in September 2022. By situating the four lectures within a composite conceptual framework, the paper discusses the relationship between the future and technoscientific processes in the context of science and technology studies with an emphasis on the performative role of futures and imaginaries in co-shaping knowledge-making practices and technological developments.

Keywords: future; technoscientific expectations; socio-technical imaginaries; promises; art-science collaborations.

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1. Introduction

In which ways and under which conditions do socio-technical expectations, promises and imaginaries co-shape the nexus between science, technology and societies? How are future scenarios entangled with policymaking and decision-making processes about technoscientific innovations and

developments? In which ways can art, exhibitions and "art–science" experiments cross-fertilise the understanding of social, cultural and ethical issues at stake in the context of new and emerging sciences and technologies? Such questions are currently at the core of several research streams at the intersection of science and technology studies (STS), the sociology of expectations, and media and cultural studies that are concerned with analysing how and to what extent promissory narratives, forward-looking statements and expectations are not only hypothetical discursive entities navigating towards uncertain and unfathomable future scenarios but also performative objects at work in real-time practices (Konrad et al. 2017).

This special section of "Tecnoscienza" hosts four invited lectures from the teaching and mutual learning activities held during the VI STS Italia Summer School titled *Disentangling Futures: Promises, Scenarios, Experiments* organised at the University of Padova in September 2022.[1] The scientific programme of the summer school were deeply entangled with an ensemble of analytical issues, theoretical perspectives and concepts that in the last few years have emerged with renewed vitality in the STS field with the aim of respecifying the analytical lenses and methodological approaches in the understanding of technoscientific innovation processes – i.e., how the performative role of futures, anticipatory expectations and imaginaries is actively engaged in co-shaping knowledge-making practices and technological developments.

In the context of STS, the identification of the future as an analytical focal point for analysing technoscientific phenomena surfaced around the 1990s and split into several research streams. This fertile debate, which explores how real-time technoscientific practices mobilise and intertwine with future-oriented narratives, has provided a conceptual scaffold for the teaching and mutual learning activities carried out during the VI STS Italia Summer School in Padova. Such activities have coalesced within the lectures collected in this special section that covers various issues, from the assessment of long-term futures of technological innovation that helps scholars and policymakers consider how future-oriented socio-technical imaginaries act upon real-time technoscientific innovation to actionable anticipatory frameworks and normative scenarios adopted to intervene in science, technology and innovation governance and policymaking.

The conceptual scaffold of the summer school – as the four lectures outline – relies on the acknowledgement that the research body about the role of imaginaries, discourses and practices related to the construction of technoscientific futures is increasingly articulated. In this respect, a crucial turning point in the STS literature about the role of the narrativisation of the future can be traced back to the early 1990s with the emergence of a distinctive *sociology of expectations* pioneered by Harro Van Lente (1993) in his widely cited PhD thesis. In subsequent years, this seminal work evolved into a broad research stream intensely focused on the role of future-oriented narratives as a crucial element in sustaining the

mobilization and alignment of material and immaterial resources, skills and public interest around emerging, and sometimes controversial technoscientific fields, such as synthetic biology, nanotechnology and postgenomic developments (Brown et al. 2000; Burop et al. 2006). A wide array of concepts and perspectives have emerged to advance the study of the performative nature of future-oriented technoscientific expectations and visions. Performativity here refers to the relevance of considering and locating anticipatory knowledge and future-oriented visions within the multiple dynamics of real-time innovation practices. Such practices give shape to heterogeneous networks in which diverse agents can cooperate and conflict by mobilising various resources (e.g., available technologies, financial means, legal frameworks, scientific evidence and deliberative procedures) as well as visions and expectations about suitable or undesirable futures to acquire support for materialising their ideas in cogent and actual scenarios that may orient everyday research activities and living experiences (Brown and Michael 2003; Michael 2000).

More recently, the notion of *socio-technical promises* has gained further relevance among scholars and policymakers interested in understanding how the management of visions related to futures – which also embed values, ethical statements and notions about potential benefits or disadvantages arising from innovations – is actively performed by research and innovation communities within a "promissory regime" (Âpreda et al. 2014; Audétat et al. 2015). Following this line of inquiry, concepts such as "promissory organizations" (Pollock and Willimas 2010) and "promissory bio-objects" (Crabu 2014) have been elaborated to enhance the understanding of the relationships between anticipatory knowledge, technoscientific expectations and forward-looking statements on the one hand, and the sociomaterial dimension of knowledge-making practices and technological innovation on the other.

Within this perspective, the notion of *socio-technical imaginaries* (Jasanoff and Kim 2015) became widely adopted to address the implications and dynamics related to the narrativisation and symbolic dimension of technoscience in society. The notion of socio-technical imaginaries allows scholars and practitioners to address and disentangle how the social, normative and institutional future-oriented visions and expectations can influence and orient collective choices, preferences, values and behaviours about what is desirable and appropriate or inappropriate in the context of our everyday technologically dense societies (see Bruni et al. 2013).

Within this ongoing debate about the role of imaginaries in the context of science and technological innovation, the four lectures comprising this special section further contribute to disentangling the ways in which anticipatory expectations and forward-looking statements may act as discursive devices capable of reshuffling and reshaping the modalities and conditions under which various stakeholders and concerned groups of people manage real-time technoscientific issues. It is worth noting that

the narrativisation of technoscientific innovation seems to be particularly relevant when breakthrough devices, research programmes and emerging scientific fields are increasingly exposed in the public sphere to manufacture legitimacy and social acceptance of innovations (e.g., human genome editing, human enhancement and self-driving car).

While expectations are crucial in framing and co-defining the settings, conditions and arrangements within which technoscientific phenomena occur, in the lecture *The Roots of Neglect: Towards a Sociology of Non-Imagination*, Barbara Prainsack (2022) makes the case that the lack or absence of (alternative) expectations may also have a role in shaping the future itself. Starting from the widely accepted assumption that the performative power of visions and expectations can orient the multiple ways of being, knowing and intervening in our everyday dense societies (e.g., which projects to finance, who should handle them, who should enjoy their benefits, and who should be responsible for any negative consequences), Prainsack shows how the absence of desirable counter visions and narratives about the future can explain why concerned group of people do not trigger a change of highly questionable socio-technical regimes and related arrangements that can be perceived as detrimental to human and planetary well-being. Hence, in outlining a *sociology of non-imagination*, Prainsack calls for the need to analyse and understand the ways in which the absence of counter-visions defines the scaffold for the perpetuation of various forms of injustice and exploitation of people and the environment.

By opening a critical reading of the anticipatory governance perspective, this lecture allows us to consider another crucial dimension of the VI STS Italia Summer School, namely the collective experiments that can help us address the role of the narrativisation of the future, intended not only as a tool deeply subsumed by hegemonic neoliberal technoscience but also as a potential trigger for new critical and reflective perspectives on the interrelations between science, technology, politics and society. In particular, experiments in the co-creation and creative appropriation of scientific knowledge and technologies have paved the way for new forms of public engagement and inclusion in various technoscientific domains, thus leading to a reassessment of the interrelations between science, technology and society, while framing citizens and diverse stakeholders as active agents in shaping new potential configurations of the science-society relationship (Lezaun et al. 2017; Marres 2012).

The focus on the imaginative power of experiments and other novel trajectories of interaction between societal actors and research and innovation communities leads us to another key dimension addressed in the context of the summer school and then elaborated by the aforementioned lectures: the role of fictional narratives. Fictional representations of technoscience – including movies, literature and comics – have already started to be integrated into the analysis of emerging innovations. For example, this can be observed in studies on popular culture representations of

emerging innovations such as human cloning (Nerlich et al. 2001) and nanotechnologies (Millburn 2008). This body of research also highlights how scientists themselves can be directly or indirectly engaged in fictional imaginative production (Kirby 2011). As outlined by Marc Audétat (2022) in his lecture titled *Promising Technosciences in the Economy of Attention*, fiction should be considered tools for re-imagining counternarratives or counterfictions that can trigger imaginative processes useful for developing new theoretical lenses that can be used to better understand contemporary technoscience. In his contribution, Audétat introduces a fresh dialogue between cultural and media studies and STS to expand the sociology of expectations and focus on how technoscientific visions can gain public resonance and popularity by circulating within the public sphere. Starting from this analytical premise, Audédat elucidates how and under what conditions technoscience is framed as a matter of promising and visionary practices and discusses the implications raised by such practices in respecifying the interface between science and society.

Following this line of inquiry about highly mediatised and spectacularised technologies, a lecture by Philippe Sormani (2022) titled *Remaking Intelligence? Of Machines, Media, and Montage* critically reflects on the current renewed interest in artificial intelligence, especially machine learning techniques, as a technoscientific field marking the spectacular revival of automated induction. Sormani mobilises an ethnomethodological approach and develops a practice-based video analysis of a demonstration of "machine intelligence." By examining the complex interplay between machines, media and montage, the lecture highlights how specific forms of "enchanted determinism" (Campolo and Crawford 2020) are enacted as situated performance.

A final point at the centre of the summer school, articulated in the closing lecture by Silvia Casini (2022) titled *That Obscure Object of Desire: Some Notes for a Slow Art-Science*, concerns the role of art and artistic exhibitions in shaping and understanding technoscientific-driven innovation processes (see Halpern et al. 2022; Sormani et al. 2018). As outlined by Casini, art-science collaborations can be considered privileged loci for experimenting with new visions and imaginaries about technoscience. As such, art-science collaborations elicit critical reflections about the nexus between science, technology, politics and society and invite us to dismantle and cross epistemic, disciplinary and professional boundaries. By highlighting the transformative power of art-science-based experimentation and critically overcoming naïve conceptions of creativity, Casini adeptly outlines art-science collaborations as a strategy for cross-fertilizing and reframing strategies of engagement in technoscience.

Overall, this special section invites scholars, policymakers and concerned stakeholders to rethink the role of expectations and future-based narratives in innovation dynamics, thus reopening the doors of science and technology to unexpected agents, discourses and skills. This is urgent,

since contemporary challenges such as the current global climate, health, social and political crises not only necessitate assessments of the temporality of technoscientific innovation processes in the present, with their controversies and conflicts, but also imply the need for a collective and creative effort to draw more sustainable and socially desirable futures.

Notes

[1] The VI STS Italia Summer School was held in Padua from 27 September to 1 October 2022 and was organised by STS Italia in collaboration with the Department of Philosophy, Sociology, Pedagogy and Applied Psychology (Fisspa), the Padova Science Technology and Innovation Studies (Pa.S.T.I.S.) research unit of the University of Padua, the STS Lab of the University of Lausanne with the support of the European Association for the Study of Science and Technology (EASST) and the journal "Tecnoscienza." See http://www.stsitalia.org/6th-sts-italia-summer-school-disentangling-futures-promises-scenarios-experiments-27th-to-october-1st-2022-padova-italy/.

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The Roots of Neglect: Towards a Sociology of Non-Imagination

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Abstract: The sociology of expectations has helped academics and policy analysts to understand how socio-technical imaginaries are not only hypothetical and "in the future", but how they create realities in the present. They do so by shaping what gets funded, who gets hired, and even how people lead their lives as they consider some futures more likely than others. While this focus on the performative power of specific visions and expectations has been hugely important, there is another situation that has arguably been at least equally impactful on the present: the absence of (alternative) expectations of the future. It is the absence of specific imaginations of the future that people deem desirable that explains why, despite being fully aware of political and economic practices and arrangements that are detrimental for human and planetary health, we have not changed these arrangements.

Keywords: non-expectations; neoliberalism; strategic ignorance; complexity; crisis.

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1. Introduction: The State We're in

It has become a truism to say that the COVID-19 pandemic has exposed the fault lines of our societies. This is also why, even at the very early stages of the pandemic, some people were hesitant when politicians talked about the way back to normal life. This sentiment was trenchantly expressed by an anonymous graffiti artist in Hong Kong: "Normal was the problem in the first place" (Wintour 2020; see also Wagenaar and Prainsack 2021).

What exactly was the problem? I believe it was – and is – nothing less than the way we organise our society, including our economy. It is harming people and destroying the planet. Racism, sexism, coloniality and oth-

er forms of injustice and exploitation – of people, and of the environment – are written into our social, political, and economic institutions. In many world regions, people suffer (and often seek to flee from) climate change, violent conflict, and sexualised violence. Social and economic inequalities are increasing almost everywhere. Anne Case and Angus Deaton (2020) famously coined the term "deaths of despair" to refer to the phenomenon that more and more people in the rich world no longer have any motivation to stay healthy and fit, or even alive; there is nothing for them to live for. Young people are afraid that even if they manage to make a good living and live as healthily as they can, they may not make it to old age as climate change will end their lives prematurely.

The reasons for this situation are manifold and have been analysed in a broad body of literature within and beyond of academia in recent years. At the heart of the problem lies what Hendrik Wagenaar calls a "mirage of economic democracy" (Wagenaar, 2023). Because of the intrusion of the corporate-financial domain and its values and practices in every sphere of society as well as out private lives, Wagenaar argues, democratic politics (and policy) have lost their power to shape the workings of society. As Karl Polanyi described in his 1944 seminal book (Polanyi 2001 [1944]), although markets – understood as spaces for the exchange and sale of goods – have existed almost as long as humans have, a "great transformation" took place in the 19th century. Local and regional markets grew together into a large system that began to regulate itself. Markets became increasingly powerful. Gradually, even those things that had previously been freely accessible and belonged to everyone, such as labour or land nature, were transformed into market goods – often by force of law. Those who worked as independent producers were turned into wage labourers (e.g., Maddison 2008). Control over the production of money was given to private banks, long before "debt-driven growth and deregulated finance" became key elements of neoliberal economics (Bollier and Conaty 2015; Pettifor 2017; Wagenaar and Prainsack 2021, Chapter 8). While "the market" had previously been a part of society, it now began to break away from it and become a sector of its own, obeying its own laws. At some point, society no longer ruled the market economy, but the market economy began to dominate all most other aspects of society. This process has progressed so far that today that most of us can no longer imagine a world without the primacy of economic thinking. At the same time, politics creates laws that support the expansion of markets instead of containing them. Neoliberalism, which is sometimes described as the pushing back of the state, is much better captured as the use of government and governance to expand the rationales and rules of markets – and to support the interests of powerful market participants who have become quasi regulators.

The result are societies in which social and economic inequalities continue to grow. Because "the market" (and "the economy" more broadly) are treated as separate from society, as something that observes their own

rules and should not be "interfered with", we have become accustomed to their destructive effects on the environment and the wellbeing of people. The conceptual and categorical separation of "the economy" and the rest of us has arguably made it possible that the same people who book a "green" holiday in eco-sustainable accommodation fly around half of the world to get there. That we have "ethical fashion" delivered to our homes by a UPS driver in a truck without air condition in the searing heat – a situation which made headlines in the summer of 2022, not because it was an exceptional incident but because the company refused to do anything about it even after one of their drivers died (Fox 11 Digital Team 2022).[1] The same people who share stories of labour exploitation on social media, continue to buy goods and services from the offending companies, and continue to engage in the very same practices that caused the root of the problem – here, climate change – in the first place. Framing this situation as hypocrisy or cognitive dissonance of a comfortable, well-off middle class is not very helpful – there are structural grounds for the discrepancy between political ideals and everyday practice.

Why is this the case? And why have we not changed the arrangements that cause the problems that our societies are acutely dealing with? With the COVID-19 pandemic still not behind us, and amidst wars and a very tangible climate crisis, the flaws in the way we have organised our economy, our political decision making, and our social order, is becoming painfully visible – and tangible. It should not have taken the COVID-19 pandemic for us to realise that something is very wrong. We have been aware of these issues, and often also know how they could be addressed. There is no dearth of literature on the human causes of climate change, the detrimental and even deadly effects of austerity, and the political, economic, and health-related outcomes of grave inequalities. Why have we not something to change this situation?

In the remainder of this article, I will attempt an explanation. I will explore several possible rationales for why we, collectively, do not act. I will conclude that a sociology of non-imagination that – like the way in which the sociology of expectations has helped us do within its remit – could help us understand the ways in which the absence of alternative visions and expectations creates facts on the ground.

2. Why We Don't Act: Four Attempts at Explanation[2]

There is one explanation for why we do not act that I will not discuss in this section, despite its importance. It corresponds with a good part of the body of critique of neoliberalism. In different variants and forms it revolves around the argument that neoliberalism, by using institutions and instruments of public governance to expand market interests, has eroded the key function of governing, namely, to increase the welfare of

people. I strongly agree with this critique and owe much of my own thinking to it. At the same time, I seek to go beyond it in the sense that I am interested not only in how this has happened (which is explained very well by Crouch 2011, for example; see also Gerstle 2018) but also in the deeper question of why we, as members of our societies, have allowed to let this happen. The explanations that I explore in this section are thus to be seen as complementing the explanations building upon neoliberalism critique, and not competing with it.

2.1 "More Prisoners than Students": Our Societies Are Too Old

In his 2018 book on *How Democracy Ends*, the English historian and political theorist David Runciman offers an answer to why, in so many democracies shaken by corruption, perennial crisis, and worsening conditions for workers and other groups, no political change is on the horizon. Runciman exemplifies his argument with the case of Greece. Even before the COVID-19 pandemic, austerity measures had led to cuts in public budgets and services as well as income losses for many citizens, which in turn had contributed to a decline in physical and mental health in the population (e.g., Stylianidis and Souliotis 2019). Runciman is interested in why there are no revolutions[3] in democracies that struggle as much as Greece does. Part of the reason, he argues, is that Greece – to stick with this example – despite the hardships that its people have experienced in recent decades, is a rich country compared to many other countries in the world.[4] Between 1968 and the financial crisis in 2008, the Greek economy grew five-fold (Alogoskoufis 2021; see also Runciman 2018, 45). Greater wealth is a disincentive for radical change for those who remember how it used to be before things started to improve. In Runciman's words, people "think twice before tearing the whole thing down" (Runciman 2018, 45).

But how about the younger people, those who do not remember what things used to be like before the economy started to grow in the 1960s? This, Runciman argues, is exactly the point: there are not so many who do not remember. Greek people are old. In fact, they are one of the oldest societies in the world, with a median age of over 45. Only Japan, Germany, Italy, and Hong Kong have a higher median age (WorldData, n.d.). The youngest countries, Niger and Uganda, have a median age around 15. In Greece, there are more people in prison than studying at university, Runciman notes. In such societies, high youth employment does not fuel political protest simply because there are not so many young people to rise up. Indeed, research shows that countries with large proportions of young people – so-called "youth bulges" – are more likely to experience political violence (Urdal 2006).[5] If political uprise is a young people's game, then societies such as Greece are simply too old to play it. Today's "battles are taking place between men and women in business

suits armed with spreadsheets" (Runciman 2018, 44) – and these battles are not about what a new society should look like.

To be clear, Runciman is not suggesting that the advanced median age of Greek society – and that of most other societies in the Global North[6], in fact – is the only or even the main reason that is not radical change. Next to the growth of wealth over the last decades, another important argument, according to Runciman, is that democracy has very little to promise anymore. Not because there is anything wrong with democracy, but because what it has to offer it has already delivered: it has given people dignity and benefits (Runciman 2018, 235). In Runciman's words,

> The battles to expand the franchise have been largely fought and won. The state bears the burden of the huge range of public services that it is expected to provide. Levels of debt, both public and private, are high. Taxes could be higher – they have been higher at periods over the past hundred years – but the popular appetite for paying more is very limited. The current populist backlash in the established democracies is happening in places that have been doing their best with democracy for a while. (Runciman 2018, 101).

In summary, the first possible explanation for why we are not standing up to change the way that our society is organised, and the way in which our economic model is destroying people and the planet, is that we are, collectively, too old, and too invested in how things are. Many of us have grown into this system and lived in it for such a long time that we cannot imagine anymore that things could be different. We are implicated in it. But some of us do protest, you might think – and you would be right, of course. But the problem is that this action does not change the way things are. In the next section, I will argue that people's actions to change the status quo are sometimes not even seen.

2.2 We Do Act, but It Cannot Be Seen through the Traditional Lens of Participation

Political scientists tend so see citizen participation only when it takes place within the institutions of electoral democracy – such as when citizens start a formal initiative pushing for a change in legislation, when they turn up for a referendum, or cast a vote – or when they engage in political or even violent protest. The reference point is, thus, always the formal institutions and processes of collective will formation; citizens participate by being active within these institutions, or against them. What political science, and also mainstream policy analysis, does not see is when citizens engage outside of these formal institutional landscapes. For example, when citizens create solutions to problems of missing or defective social care (Wagenaar 2019), when they produce their own green energy, or when they change the way in which goods and services are traded from

commercial profit-driven modes to modes that foreground the wellbeing of people and the planet.

Innovation studies have found that what they call "household innovation" – that is, "the dedication of household resources to creating a product or process that will generate a service flow in the future" (Sichel and Von Hippel 2021, 639) contributes much more to the economy than commonly assumed – because it is largely invisible to analysts (Sichel and Von Hippel 2021). What Sichel and Von Hippel conclude for technological innovation seems to apply also to other types of innovation – such as the care cooperatives and other social enterprises in the Netherlands that Wagenaar (2019) writes about. One big advantages of such citizen-initiated and citizen-led organisations is that they have links to the communities they are serving, instead of being implemented top down. They respond to the specific characteristics and problems of the community, instead of representing a standardised, anonymous answer to a problem that other communities may have. Despite their significant innovative potential – e.g., by establishing new modes of service provision, by creating local non-profit barter economies, or by challenging the normative conceptions of the issues that they set to solve (see Wagenaar 2019, 310), these social enterprises are often not seen – neither by policy makers nor journalists nor most academics. Besides the limitations of the theoretical lenses of scholars and the pragmatic and ideological ones of policy makers, there may be a deeper, structural reason for this, which I will turn to next.

2.3 Hegemony and Complexity

In our 2021 book *The Pandemic Within: Policy Making for a Better World*, Hendrik Wagenaar and I attribute our collective inability (and not only unwillingness) to change the status quo to two main predicaments: complexity and hegemony. Talking about complex systems is equivalent to talking about the intrinsic structure of the world we live in. It is impossible to wish complexity away – it is a characteristic of both social and material reality. It comes from the interactions between the system's various components, not only from the actions of individual components. This makes it so hard to understand complexity, and impossible to predict it. This means that even if we want to act on a specific problem, if we have analysed why it needs addressing and how we want to address it, complexity can come in the way. In public policy, this phenomenon is known as the "law of unintended consequences": policy solutions, despite being well intended and designed well on the surface, can be ineffective or even make problems worse instead of alleviating them (see Sterman 2002) – because the world talks back. Within complex systems such as the world we live in, when we intervene on one specific problem the repercussions of that intervention can be felt in many or even all other

fields. Although we are aware of the individual components of the issue, we find it difficult to understand how they work together:

> Policy resistance arises from the mismatch between the dynamic complexity of the systems we have created and our cognitive capacity to understand that complexity (Sterman 2002, 5).

This situation can be avoided only if policy makers try to harness complexity, rather than denying or resisting it (e.g., Wagenaar 2007). Recognising complexity is not the same as declaring something to be complicated. An internal combustion engine, for example, is complicated: it contains many parts which need to interact in precise and predictable ways with all other parts. A small group of friends, however, can form a complex system; it is often impossible to predict what they will do. Emergent outcomes, to use the terminology of complexity theory, are the results of the group members' interactions and actions. Emergence signifies that the features of the parts cannot fully explain the whole. This contradicts traditional policymaking, which tends to use the characteristics of individual components as our leverage points for group intervention (see also Wagenaar 2007). More often than not, policy makers who do not acknowledge and harness complexity attribute the failure of their policies to individual behaviour. Rather than gaining a more comprehensive understanding of the structural roots of these behaviours, they blame climate-destructive practices, for example, to individual "choices" and try to persuade or nudge people to change these.

Hegemony, which we describe as imaginative captivity, is the second reason that we have not yet acted on the state of the globe (Wagenaar and Prainsack 2021). Hegemony renders us unable to look beyond our immediate, moral, and practical concerns. In a world that makes sense to us, we live, work, breathe, and "know our way". Because we have been socialised into specific systems of practices and judgments, the features of these systems have become self-evident to us. They comprise specific methods of appreciating, seeing, and acting. Their shape and meaning are built into the very structure of our language.

Hegemony serves as the reference point for how we are in the world. For instance, when we constantly hear experts, politicians, and news anchors use the word "economy", we assume that there is an entity, distinct from the rest of society and in opposition to the natural environment, that is run by professionals (business managers, economists, the financial press, central banks, and so forth), operates according to its own rules, and that its smooth operation somehow ensures everyone's well-being. The reporting of statistics such as fluctuations in the gross domestic product, the number of unemployed people, the rate of inflation, and other metrics confirms that depiction day in and day out (see also Mazzucato 2018). We assume the existence of the economy, and even when

we are critical of certain aspects of it (such as large inequalities in wealth, or its contribution to global warming), it does not occur to us to question the category and the tacit assumptions of its functioning itself. We do not notice that it is a self-referential system that reinforces itself by the very metrics that it uses. In this manner, hegemony concerns the very intelligibility of our world, the way we determine what can be judged true or false in the first place. The "economy", as discussed at the beginning of this paper, as a separate realm, performing to its own laws, to be managed by people with specialised knowledge, is the tacit background of our life-world, somewhat like a landscape or cityscape. We live in it, but we do not see it (Wagenaar and Prainsack 2021).

Hegemony also has a firm hold also over our ethical considerations, as it entails a particular moral order. It confers intellectual authority to designated experts and, conversely, withholds it from others, such as "ordinary" citizens or marginalised groups.[7] Think of the awe with which the pronouncements of Central Bank presidents or captains of industry are received by the media, while those drawing attention to human-made climate change are dismissed as hippies or eco-warriors. Closely related to this is how hegemony also shapes moral sensibilities. It instructs us how to feel. In our 2021 book Hendrik Wagenaar and I took a bet that people looking back at the 2020s from a few decades in the future will be shocked when they read how governments demonised welfare recipients, condemned hundreds of thousands to a precarious existence by abolishing worker protections and fighting unions, or destroyed precious public sector institutions by handing them over to private corporations, or how corporations condemned hundreds of thousands to a precarious existence by abolishing worker protections and fighting unions. They may experience the same kind of moral outrage that many of us are experiencing right now at historical accounts of blatant sexism and racism when they read or see how we condoned an economic system that forced retirees out of their homes and into a precarious nomadic life (Bruder 2017). In our book we imagined how in the future, historians will look back at today's debates where demands for workers' rights or state-regulated universal health are met with angry cries of "socialism". We believe – and hope – that there will be a world where the moral inertia towards these destructive aspects of our economic and political order will be met with astonishment. That we do not perceive great outrage at these things happening in front of our eyes today – this is hegemony at work.

What makes it difficult to break free from hegemony is that we cannot merely think ourselves out of it. Hegemony, understood as imaginative captivity, is anchored in our personal, social, economic, and political practices. As we argue in our book,

> the world is self-evident to us because it rests on a bundle of practices, into which we have been thoroughly socialised and which are held in place

> by institutions, beliefs, understandings, ideologies, and identities. This is where hegemony and complexity meet. Try to reform one aspect of this dense structure (for example, introduce sustainable production methods) and you run into another set of institutions and practices that push back (the international finance system, or the large network of carbon subsidies, for example). Resistance to change is not so much a psychological quality, as Elisabeth Shove (2010) pointed out, but the effect of being caught in a web of practices. When the solutions to improve a given situation are framed in the same terms as the very situation you seek to change, you know you are in a hegemonic situation. Or, reversely, when some reasonable proposals are met with incredulity, dismissed as impractical or not worthy of serious discussion, this is another sure sign that you find yourself caught up in a hegemonic situation. (Wagenaar and Prainsack 2021, 18)

To give an example: what do you think when you hear that, to save money, governments need to spend? Most of us believe this statement to be false because we have been told for years and decades that it is. That this statement is false is part of the hegemonic narrative we grew up with. But this statement is correct: to save, governments need to spend. Investing in public services and infrastructures creates value and saves money for solving the problems that austerity created later on.[8] A state does not save money when it leaves people to their own devices. Unlike a company, a state cannot – and obviously should not – lay off people. People living in long-term unemployment or abject poverty are not only experiencing great hardship, but they are also costly for the state. If ethical arguments are not sufficient to make the case for government spending, economic arguments should: having large numbers of people living in poverty is expensive. It may be cheap in the short run, but adds up later. A string of research on the social costs of austerity programmes testify to this (e.g., Karger 2014; Ortiz et al. 2015). Despite all these facts, most of us believe the statement that states need to spend in order to save to be false.

Taken together, hegemony and complexity go some way to explain why we, collectively, have not managed to change the problematic state of the world so far. Many are trying to break free from the current order of things; they protest oppression, injustice, dictatorships, and the exploitation of people and the environment. But usually, their actions remain without a lasting effect. Sometimes the reason for this is that those who stand to benefit from the status quo actively work to thwart attempts to change it – think of voter suppression, the prohibition or sabotage of unions, or the simple lobbying of governments for the interests of the carbon industry or other big business. Very often, however, their protest is not only dismissed by powerful elites but also by their fellow citizens – those people who suffer from the precarisation of labour, climate change, and illiberalism as much as they do. That these fellow citizens do not join the protest, that so many of us believe it is better to stick with the "devil we know" rather than leap into the unknown, and that so many feel that

it would be too messy to uproot a system that they got used to – this the result of the joint effect of hegemony and complexity.

And there is yet another, and at least equally important, problem that helps to explain why we do not act.

2.4 We Cannot Envisage a Future for Which Our Current Action Would Be Necessary

In 2021, social theorist Jana Bacevic wrote a text titled "Why we don't act" (2021), referring to the failure of so many governments all around the world to take effective action to protect people from COVID-19. She drew an analogy to the dissolution of Yugoslavia, when there was sufficient knowledge for people to have been able to predict what would happen, yet they were still taken by surprise. Bacevic explained people's inertia in the following way: "It was rather that they could not imagine a future in which their present action was required" (Bacevic 2021). Bacevic said something of key importance here. Even if we know what is wrong with the status quo, even if we know how we could address specific problems, we lack a bigger narrative of why we should act. We lack a vision of what our societies would look like in a better world. Without such a vision, given how difficult it is to change our existing political and economic order, it is not worth bothering.

The lack of such a vision, and a narrative of how we get there, also helps to explain one of the seeming paradoxes of democracy. In his most recent book, Thomas Piketty (2022) showed that although the world has become more equal in the last 100 years, not much has changed for the 50 percent of people who held virtually no share of the global wealth then, and who still hold hardly any wealth at all today. For those who live in democracies, why have they not voted out the political elites who are responsible for these persisting inequalities (which in many democracies are actually growing)? For those who live in undemocratic, autocratic regimes, why has there been no revolution? Piketty does not answer this question in his book. I believe that Bacevic does, at least in part. It is because of the power of stories that convey that if the economy does well, everyone will benefit. That high income or corporate taxes stifle innovation. That the state must save money by not spending it on people. And that the economy is a system separate from the rest of society that one must have expert knowledge of in order to criticise it – not to mention "interfere" with it. These stories are articulated over and over by almost all societal actors – and believed, and retold, by many of the people who suffer from it. They are hegemonic in the sense we described above. More often than not, information about the fate of disadvantaged people does not become part of the main narrative – because it does not fit. It has no anchor point. To give a concrete example: if income is framed as payment for labour, then there is no conceptual space for people to receive an income for

anything else than labour. Not only does this make it impossible to conceive of income that people may "deserve" if they do not work for it – such as an unconditional basic income – but it also moves out of collective sight a huge source of income of the wealthy, namely income from capital.

The fact that the suffering of many people has no conceptual frame, no anchor point, represents an instance of epistemic injustice, which Miranda Fricker (2007) famously defined as injustice experienced by people in their capacity as knowers. According to Fricker, epistemic injustice typically appears in one (or both) of two forms. The first is testimonial injustice, when the knowledge of a person is dismissed due to prejudice (because she is a poor person, or "only" a patient and not a doctor). The second form, hermeneutical injustice, takes place when people have no reference point to even conceptualise or articulate their disadvantage. Fricker's own example is sexual harassment experienced by a person at a time and place where there is no societal conception of this phenomenon. The person may feel hurt or even traumatised without being able to articulate what is wrong. This, I argue, is happening to the majority of people in many countries at the moment, who are living in poverty or worrying about their livelihoods while a small stratum of people is becoming richer. Many of them feel that there is something wrong with this situation, but they have no conceptual anchor point to articulate how it is wrong, and that – and how – it could and should be different.

Ruha Benjamin (2019, 162) argued that "[c]alls for abolition are never simply about bringing harmful systems to an end, but also about envisioning new ones". The same is true for our narratives about the increasing power of tech corporations and other multinational businesses; our narratives focus on the obscene wealth and power that they are accumulating, and not on the harm that this does – or how things could be different. Referring to the surveillance studies community, Daniel Susser (2022, 297-298) argued that:

> [u]nless we introduce competing visions of a good technological future, the most we can hope for […] is to realize Silicon Valley's vision – minus some of the harm.

We need a vision of the future that integrates all fields of policy making, and all fields of societal practice, of what a better future could look like. If we had a narrative that focused on why so many people in most countries of the world are still struggling, instead of a narrative that focuses on progress and increasing wealth, there would be much more pressure on all of us to act. As Bacevic argues, it would need to be a story about what a future should look like for which it is worth acting upon the present.

3. Towards a Sociology of Non-Imagination

The sociology of expectations has been an important and fruitful field of academic and policy-relevant exploration and insight. Despite its focus on technological innovation, its core tenet that expectations are not merely feelings or thoughts but instead "an intensely future oriented business with an emphasis on the creation of new opportunities and capabilities" (Borup et al. 2006, 285) is relevant far beyond the field of science and technology. It has shown, as Kornelia Kondrad and Knud Böhle (2019, 102) put it, how:

> [c]collective expectations and imaginaries, their explicit claims and implied framings, prestructure which developments are considered relevant and urgent, possible or inevitable,

in fields as diverse as biotechnology, healthcare, and green technologies.

I argue that, in addition to the sociology of expectations, we need a sociology of non-expectations – or, more precisely, of non-imagination.[9] As Susie Scott (2018) pointed out, understanding deliberate inaction is not the same as making sense of other, non deliberate forms of non-doing. Analysing political struggles to suppress actions to abolish racist or sexist policies, for example, is not the same as understanding instances where racism or sexism are not even seen as a problem, and no alternative is thus imagined. In Scott's words, we need to attend not only to "'acts of commission' (doing nothing) [but also to] more passive 'acts of omission' (not-doing/not-being something)" (Scott 2018, 4). Such as sociology of non-expectations (or a sociology of nothing, as Scott would call it), is not merely of academic importance. The absence of visions about what an alternative, better, future should look like creates facts on the ground. It makes us accept the status quo, or the supposedly "natural" course of things, as a given, and it makes us put up with its negative effects. In the worst case, it naturalises specific distributions of power and agency, and suggests that these are beyond our control.

There are several concepts and bodies of work that could underpin such a sociology of non-imagination. An obvious one is a form of soft power that political scientist Peter Digeser called the Second Face of Power (Digeser 1992; see also Dahl 1957, 202-203). The First Face of Power, following Digeser, is the one that most people have in mind when they think of power. It includes an open conflict and crude domination, sometimes even brute force. It materialises when an actor – a person, an organisation, or a state – makes another do something that the latter does not want to do, either by use of force or direct pressure. The Second Face of Power, in contrast, refers to situations in which an actor prevents somebody else from doing what they want to. The recognition of this less openly visible dimension of power is largely owed to the work of Peter

Bachrach and Morton S. Baratz who, in a landmark article in the early 1960s, drew the attention of political analysts to:

> instances of power where actors are not constituted as parties to a conflict and/or issues are not defined as contentious (c.f. Bilgin and Elis 2008, 9; see Bachrach and Baratz 1962; 1963).

Analysts of the Second Face of Power look at decisions that were not made, or processes that resulted in certain items never making it onto agendas. As such, the Second Face of Power is closely related to Miranda Fricker's notion of epistemic injustice – the injustice that is done to people in their capacity as knowers, when their expertise or experience is ignored due to prejudice or other problematic reasons. It goes beyond epistemic injustice, however, in that it also often has tangible social, economic, and political consequences. And while some practices that fall under the remit of the Second Face of Power would count as deliberate inaction in Scott's typology – e.g., if they result from a political agenda not being pursued because its proponents are being actively silenced – the Second Face of power can be a useful analytical lens to recognise power as a tool of inaction.

Another important body of work that a sociology of non-imagination could draw upon is scholarship on ignorance, pioneered by Linsey McGoey. Different forms and meanings of ignorance come to bear here. *Strategic ignorance*, as many readers of this journal will know, refers to the deliberate creation of ignorance for strategic purposes (McGoey 2019) – such as the throwing into doubt of scientific evidence on human-made climate change. *Useful unknowns* (Bacevic and McGoey 2021), in contrast, are mobilised when policy makers and other actors gain from "genuine" unknowns – such as the impossibility to know what the next mutations of the SARS-CoV-2 virus will look like. The midpoint between a useful unknown and strategic ignorance is what Bacevic and McGoey call *surfing ignorance*. It conveys "the active, institutional capacity to willfully steer 'unwilled unknowns' to meet different goals" (Bacevic and McGoey 2021, 2). It happens when decision makers choose not to look for evidence on an unknown because they fear that this evidence could go against their interests, or conflict with their goals in another way.

A third tradition that a sociology of non-imagination could be informed by is Post-Normal Science, which was introduced by Silvio Funtowicz and Jerome Ravetz in the early 1990s (Funtowicz and Ravetz 1993; see also Dankel et al. 2017). In contrast to normal science in the Kuhnian sense (e.g., Kuhn 1962), which is based on the solution of scientific "puzzles" that are described and solved within established scientific paradigms, in some situations, policy development requires Post-Normal Science: namely in situations where facts are uncertain, values are in dispute, stakes are high, and decisions are urgent (ibid). Understood not as a replacement but as a complement to normal science, within Post-Normal

Science, both the problem descriptions and the solutions are considered according to criteria of the communities that are affected by the policy or decision based on the science. Going beyond regular public participation exercises, Post-Normal Science turns the traditional domination of (supposedly) hard facts over (allegedly) soft values on its head: local, community-based knowledge can turn out to be the most robust reference point for how a problem should be framed and addressed to be solved effectively. It overcomes the imaginative hegemony of established paradigms that typically limit our actions already at the point of posing the problem in a particular way. In this way, Post-Normal Science does not only help us to understand why certain problems cannot be solved effectively, and why we cannot imagine alternatives, but it can also help us to build these alternatives – which I will focus on in the final section.

4. Conclusion: Gardening, Not Engineering

In the previous sections I have discussed several explanations for why we have not acted on the status quo, despite knowing how harmful our way of working and living is for people and for the planet, and despite solutions having been suggested for several of these problems. For example, to address the societal invisibility of unpaid labour, and the situation that so many people work in jobs that make them – literally – ill, universal basic income has been proposed as a solution (see e.g., Robeyns 2001; Haagh 2019). Some argue that such a universal basic income – because it would reduce work commuting and change the way that people consume – would also make our lives more sustainable (for a summary and critical perspective, see Howard et al. 2019). For the latter, which is arguably the biggest challenge of all, models such as economies without growth, solidarity economies, or commons as an alternative to capitalist extraction have been proposed (e.g., Bauhardt 2014; Bollier and Helfrich 2019). But none of these solutions have been taken up and implemented by any government in the world. This is, as has been argued – and as I have sketched above – perhaps related to most democracies in the world getting older, and the transaction costs for radical change being too high for most people. It is certainly due to our being captured in an imaginative hegemony. We cannot think beyond the world that we see and enact every day.

Drawing upon the work of Jana Bacevic (2021) and others, I have argued that getting out of the mess we are in will require envisaging a future for which it is worth intervening into the status quo in a major way. It will need to be a vision of a society for which it is worth accepting the discomfort and uncertainty of braking with what we have known. Hendrik Wagenaar and I have started to sketch such a vision (Wagenaar and Prainsack 2021). A society that is oriented towards the welfare of people and the planet, we argued, requires strong public infrastructures and services

that ensure that everyone's basic needs are met, in addition to a way of reorganising the relationship between government and the business that re-establishes the primacy of the former. Importantly, this newfound power of government is not to be used to discipline and exploit people as it is the matter today; governments have been willing enablers and accomplices of the exploitative and extractive business practices that they so frequently bemoan. In contrast, it is to be used to further the welfare of all people in a society. In our book we used the example of the "Red Vienna", namely the period between 1919 and 1933, when a Social-Democratic administration developed an innovative, integrated and highly successful public housing policy. The public housing built in this period was not merely a social housing for people who could not otherwise afford a home: it was a vision of a flourishing society where everyone should be able to lead a good life regardless of their inability to pay for it. The housing estates built in this era – and many afterwards that were inspired by it – bear little resemblance with the dreariness of social housing projects in the United Kingdom or other countries. They are solid, well-built and often beautiful buildings surrounded by parks and gardens. Many of them have childcare facilities and swimming pools. There is wide agreement that Vienna's current high quality of living up to this day is directly related to the achievements of the Red Vienna period. The historian Wolfgang Maderthaner called Red Vienna "one of the most extraordinary, creative and courageous communal experiments in modern European history" (2019, 24). This is all the more astonishing as the Social-Democratic administration of Red Vienna only lasted 14 years, operated in an increasingly hostile political environment, and faced a series of momentous challenges at its inception. Yet it had a vision, a humanist-socialist vision of emancipating the working class. Our own vision for the future of our societies includes a return to "good government" in the sense of a bureaucracy and administration that is committed to making everyone's life better and proudly pursues it. It is a vision of a society in which the state is no longer a dirty word.

Which leaves us with the question of how we get there. My honest answer is that I am not sure. I know that it will require both pressure from the people and the willingness of political decision makers to take risks and take unpopular decisions. My hope is that the combination of increasing costs of living, the fallout of climate change, and other hardships will not push people to escapism or resignation, but it will lead to collective action for change. But one thing that will be crucial about implementing the vision of a future for which, to use Bacevic' words again, it is worth acting upon the present is that it should be envisaged as a project of gardening rather than engineering (see below). Complexity, as I argued above, is not to lead us to fatalism, to throw our hands up into the air because "everything is so complicated". It calls upon us to harness complexity (Wagenaar 2007) in the spirit of humility and openness and the continuously

proliferating possibilities of what Connolly calls a world of becoming (Connolly 2011). We cannot do this without having a new concept of how things not only hang but also develop together, and of our place, as humans, in this interconnected web of flows, energy and materiality.

This is diametrically opposed to how policy makers are trying to address the large societal challenges today. When EU Commission President Ursula von der Leyen announced the European Green Deal in 2019, she did it with the following words: "this is Europe's man on the moon moment" (c.f. Hutchinson 2019). She thereby framed the project of making Europe more sustainable as an engineering project. The concept of engineering, in turn, is strongly related to many of the innovations made over the past 200 years, including electrification, pharmacology, information and communication technologies, and the machines that revolutionised transportation, agriculture, and education. Some of the largest and most impressive engineering projects in the world – the Large Hadron Collider, the Delta Flood Management complex in the South-West of the Netherlands, the Oslo to Bergen line, and the Pyramids of Giza – are all examples of humankind's mastery over the natural world. They make it possible for people to cut across mountains by rail, push back the sea, look up into space, and treat diseases. This idea of human mastery is evident not only in the projects that "big engineering" has taken on, but also in the very nature of the discipline. Precision and the capacity to accurately predict how a tool, machine, or system will behave and the effects it has on the specific area of the environment in which it functions are crucial to engineering. This implies that the engineer must not only be aware of all the variables and aspects that may affect how the machine or system functions, but also have control over them.

But we cannot be in control of the planet. We are also unable to "manage" the climate because it is a complex system with which we are inextricably linked. We may be able to harness it, but we cannot and should not try to control it. Engineering sends the wrong message when it comes to building a sustainable society, regardless of how much it has contributed to global prosperity and progress and how useful the engineering metaphor has been in demonstrating that human ingenuity and perseverance can successfully tackle the most difficult challenges. The reductionist, universalist approach to knowledge can only take us so far. We cannot avoid complexity. We require more gardening rather than more engineering.

An excellent engineer should be very logical and analytically inclined, have a strong mathematical foundation, and be problem-solving oriented. A good gardener needs very different skills, such as the capacity to pay attention to, "listen to", and learn from nature. Gardening is a relationship, not a project of mastery. Even with the most thorough research and meticulous planning, a garden cannot be planned on a drawing board and then just "executed". The gardener must work with a certain amount of uncertainty because she cannot control all the factors that will affect the

outcome. She can analyse the soil structure, know everything there is to know about plants, consider the principles of garden design, and precisely dose irrigation. Even then, however, she will only be able to create a garden that is somewhat similar to the vision she has in her mind; yet, she will never be able to predict the exact result. She is unable to predict how the weather, wind, insects, parasites, and other elements that make up and inhabit a garden would act. Instead of designing a garden, a gardener takes care of one. She is conversing with the materials she works with. She can grow seedlings, weed, or sow seeds, but she can never totally master. I think this is the best way to develop and put into action a future vision.

The American ecologist Robin W. Kimmerer describes in her 2013 book *Braiding Sweetgrass* how she learnt to listen to the stories that plants had to share from her parents and grandparents. Her training in plant biology at university made her unlearn the analytical skill of hearing that her family had taught her, and to train her analytical skill of seeing. She writes:

> I honor the strength of the language [of science] that has become a second tongue to me. But beneath the richness of its vocabulary and its descriptive power, something is missing […]. The language that scientists speak, however precise, is based on a profound error in grammar, an omission, a grave loss in translation from the native languages of these shores (Kimmerer 2013, 48-49).

These words are not merely a critique of the reductionism of science; rather, they are a call to replace the grammar of accuracy, mastery, and control with a grammar of interconnectedness (Kimmerer calls it "a grammar of animacy"), which an openness for the unexpected and for that which we do not yet know but must learn from others.

Kimmerer makes use of a traditional approach to understanding, observing, and relating to the natural world that is shared by many indigenous people. It entails educating our senses as well as re-evaluating how we view the natural and human world. The idea of the world and our place in it is one of connection and process. It calls for a different perspective on time – not the hypertime that punctuates modern capitalism, but rather the slower, deeper time of growth and development. And the adoption of values such as humility, compassion, balance, and joy, where we expose ourselves to learning from nature rather than pushing ourselves on it to further our short-term exploitational objectives.

This does not mean that we should give up engineering and stop planning. The Grand and the Modest Story need not be in conflict with each other. To fight climate change, develop renewable energy sources, phase out carbon fuels, stop the loss of biodiversity and soil erosion, and deal with the effects of global warming, we need all the technological ingenuity and knowledge we can conjure. Engineering remains an important and highly suitable approach to complicated challenges – just not for complex ones. For the larger challenge to build sustainable societies, relational, and holistic modes of knowing ought to serve as our compass.

Instead of mastery and control, this is a joint process of "coming to know", as Lianne Betasamosake Simpson (2014, 7) calls it. We need to start with digging up the foundations of our society, and plant the seeds for a better one. We need to replace the roots of neglect with the roots for flourishing. And then: tend, watch, learn.

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Notes

[1] UPS were not contractually obliged to provide air condition or even a fan in delivery trucks, a spokesperson of the company said (Sainato 2022). World-wide, every summer, a growing number of workers die in increasingly hot conditions.

[2] This sub-header was inspired by Bacevic (2021).

[3] I use the term "revolution" according to the definition of Shults (2002, 1027): a revolution consists of (1) a radical mass protest; (2) a change of political power at the hands of elites; and (3) significant systems changes. All three elements need to be present for a political uprise to be qualified as a revolution.

[4] In 2022, 100 countries had a higher poverty rate than Greece (Worldpopulation Review 2022). In terms of Gross Domestic Product (GDP), Greece ranked in 51st place worldwide.

[5] The correlation between youth bulges and political violence is particularly strong in the case of internal armed conflict in starkly autocratic regimes (Urdal 2006). It should be noted that this does not mean that younger people, as such, are more likely to engage in political protest than other ones (e.g., Caren et al. 2011); what research suggests is that the existence of large proportions of young people, whose opportunity costs to engage in political uprises are low, makes political violence more likely. The youth bulge literature should be read and interpreted in conjunction with research that suggests that large population increases in societies where these are unaccompanied by increases in productivity, and investments in human and physical capital, also increases the risk of political violence (e.g., Acemoglu et al. 2020; see also Goldstone et al. 2022). It has also been found that strong labour markets can mitigate or even suppress the negative effects of youth bulges (Weber 2019), suggesting that the relationship between youth bulges and political violence is complex. (Higher education is not always negatively associated with political violence; see Østby et al. 2019).

[6] In Europe, the youngest society is Albania with a median age of about 34. The United States have a median age of 38.5 (WorldData.info, n.d.).

[7] In this sense, hegemony is closely connected to epistemic injustice, both in its testimonial and its hermeneutical form; see Fricker 2007.

[8] Another reason why this statement is true is that countries are not individual households who have to earn the money they spend beforehand, if they do not want to go into debt. But this is a story for another time.

[9] John Gardner and colleagues (2015) write about a "sociology of low expectations", based on their analysis of how clinicians develop visions of the future together with their patients that accommodate doubt and uncertainty. This work is highly valuable but very different from a sociology of non-expectation that is attentive to the performative effects of the lack of specific visions and expectations.

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Promising Technosciences in the Economy of Attention: Why Have Pessimistic Stories of Disruption and "Artificial Intelligence" Performed so Well?

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Abstract: The promises connected to emerging science and technology do not merely assist research and innovation, but are a part of it. Their diverse roles in producing hype and ensuring coordination have been extensively studied in the sociology of expectations. However, promises also circulate on a massive scale in the media sphere, as occurred with nanotechnology and artificial intelligence, recounting what the future will be like. The popularity that technoscientific visions manage to attract is less well studied and understood, although it is closely connected with how research is directed and innovation funded – and thus deserves more attention. This contribution explains why so much promising and visioneering is taking place, identifies a "regime of promising", and discusses its implications for the relationship between science and society. Drawing on cultural and media studies to expand the sociology of expectations, it attempts to better understand the role of fiction in building socio-technical imaginaries.

Keywords: promising technosciences; credibility; popularity; economy of attention; counter-fiction; scenarization.

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1. Introduction

Once, in 2017, when I was invited to a high school to talk about new technology and stimulate a debate on science and society with students of around 16, a boy who had not yet participated raised his hand and asked me:

"Have you seen the movie *WALL-E*?"

I gladly answered, "Yes I have."

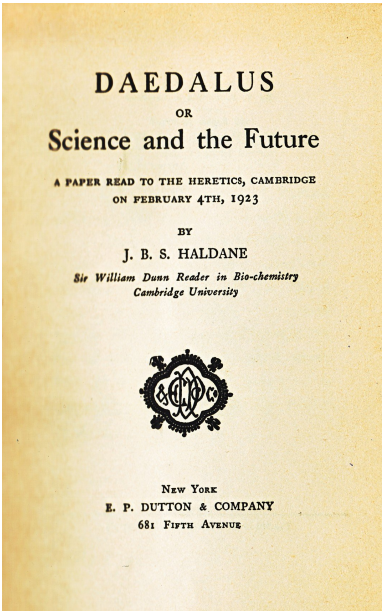
He went on, "Well, I think we're going to end up like that: machines and robots will soon be able to do everything. What I'm being taught today in school is going to be useless tomorrow. And I'll be left without a job or a place in society."

These pessimistic words echo the promises of "artificial intelligence" (AI), and especially the tone used to speak of a future of machine learning and the supposedly "disruptive" impact it will have on the job market and society. They raise numerous questions about the "economy of technoscientific promises" (Felt and Wynne 2007; Joly 2010) and its effects beyond the circles of stakeholders in research and innovation, namely on the public and media sphere, as well as on society and culture more broadly. What are the ethical implications of these promises? What should (or must) scholars try to do about them? What do they reveal about the relationship between science and society today, as compared to the recent past? What is the image of technosciences in society? Do people actually believe in such bold technoscientific claims? Here, "disentangling the future" challenges the sociology of expectations to broaden its scope of analysis and extend its work "beyond an actor-centered approach" (Sand and Schneider 2017, 22). In this contribution, I intend to explain what is meant by a "regime of promising," arguing that in order to fully investigate its implications, it must be understood in the context of the economy of attention that governs the media sphere and draw on art and literary theory to study its intensive utilization of fiction.

Before 1990, literature in science and technology studies (STS) focused exclusively on expectations and future visions was scarce, although the role played by promises has always been acknowledged. From a historical point of view, the modern sciences have generated much anticipation, as well as many utopias and expectations, that STS – while not overlooking – understood in terms of the dominant discourse of progress as a technical fix. Hence, the question arises: why did the sociology of expectations develop starting from the 1990s? Or rather: why have so many promises and technoscientific future visions recently followed one another? Appeals to the zeitgeist or the turn of the millennium are not sociological explanations of this phenomenon. This contribution thus approaches promising technoscience via the sociology of expectations, attempting to supplement it with missing analytical elements derived from cultural and media studies. I hope to show that these extensions of STS are critical for addressing what is at stake in the widely disseminated promises of technoscience and to reflect on public engagement.[1]

2. "History of the Future" in Different Literary Genres

Following Francis Bacon's *New Atlantis* (1626) and René Descartes' early ideas about organisms as machines, stories intended to stimulate the imagination and promote rational thinking became a genre in itself during the 18th century. A whole genealogy of future visions, technological utopias, and promises of progress unfolded during the 19th and 20th centuries. Technoscientific imaginaries of the past have forged the epistemic cultures of physics, chemistry, biology, and computer sciences. One example of such anticipatory vision and imaginary is "Daedalus, or Science and the Future" (1923, Fig. 1), a text read by the famous British geneticist J. B. S. Haldane at the Heretics Society, in which he coined the word "ectogenesis" (pregnancy outside the female body) – which would become possible not later than 1950 – and envisaged genetics as soon being able to modify individuals, as well as to cure or eradicate certain common diseases. It is this discourse which inspired the novel *Brave New World*, published in 1932 by Aldous Huxley (Fig. 2), mocking the promises of his friend (Atlan 2005). Interestingly, the fame of Haldane's promising discourse was made by its "counter-story", namely Huxley's satirical utopia.


DAEDALUS

OR

Science and the Future

A PAPER READ TO THE HERETICS, CAMBRIDGE
ON FEBRUARY 4TH, 1923

BY

J. B. S. HALDANE

Sir William Dunn Reader in Bio-chemistry
Cambridge University

NEW YORK
E. P. DUTTON & COMPANY
681 FIFTH AVENUE

Figure 1. J.B.S. Haldane: *Daedalus*, or Science and the Future, 1923.

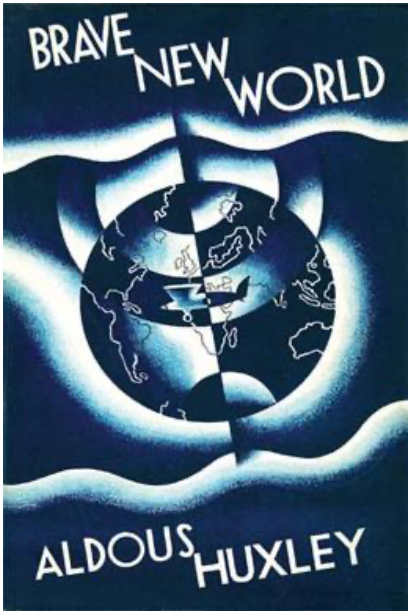


Figure 2. Aldous Huxley: *Brave New World*, 1932.

Another example can be found in the works of H.G. Wells, who, in a 1924 interview about the possibility of deriving technology from the new atomic science and the theory of relativity, answered that it would perhaps take centuries for something concrete to be developed. However, in his 1914 novel of anticipation *The World Set Free,* Wells imagines a world war in the middle of the coming century that comes to an end following the mass destruction caused by a new kind of bomb developed on the basis of atomic science (Cazes 1986, 69). This novel, dedicated to physicist F. Soddy, was read by Leo Szilard in 1933, during his flight from Germany, and it encouraged him to continue his work and to warn that an atomic bomb had to be developed before the Nazi regime managed do so itself (Cazes 1986; Guston 2012).

These two examples indicate that the future should be approached by comparing literary genres. Many anticipatory scientific visions have been based on purely technical rationality, while other genres of literature mix different types of rationality, e.g., the historical, the economic, and the technological in some philosophical essays. But literary genres underwent differentiation and were eventually separated out in the context of the "two cultures" (Snow 1959). While Wells published novels as well as anticipation essays, the specialization of fields of knowledge and common opinion about literary genres came to see science fiction as the opposite of rational scientific knowledge. The Cold War period witnessed attempts to develop fields of knowledge that anticipated the future, such as prospective science or technology assessment/technology foresight, not to mention game theory and risk assessment. For their part, the foundations of the social sciences (as they are still practiced today) were established by excluding prophesizing, prediction, and fiction. The two lessons learned from the "history of the future" are 1) that promises and fiction are constitutive of modern science and 2) that the dialogue about the future of technoscience is apparently situated in between literary genres.

3. "Fabricating Stories" for "Selling Science"

In order to foster economic competitiveness and growth following the Second World War, new layers of research funding began to be added on top of the existing positions of disciplines in academia. In the context of the Cold War, defense was also a driving force behind technoscientific research. The new research-funding schemes were organized on a competitive basis, on the model of the US National Science Foundation (1950). Following a linear model conceived as a pipeline, science policy separated "fundamental" from "applied" research, with the latter leading to R&D. In OECD countries, for about three decades everything – the economy, energy, consumption, and public health – was growing and getting better. However, to simplify somewhat, a new era started in the

1980s with the advent of emerging countries, like Japan and South Korea, which were perceived as new competitors. The integration of Europe led to the first Framework Programme for Research and Technological Development (1984-87), which supplemented national research funding with European funding. OECD nation-states implemented new forms of legitimization for additional funding, still on a competitive basis, with terms like "strategic" and "priority" research. Competition increased between nation-states, as well as within the research system.

The theoretical basis of science and technology studies was laid down in the 1970s and 1980s. It was then deployed in many different directions, leading in recent times to the development of the sociology of expectations. Two early works in this field are worth mentioning here: the editor of the 1979 book *Controversy: Politics of Technical Decisions*, Dorothy Nelkin, published *Selling Science: How the Press Covers Science and Technology* in 1987. Among the many different issues discussed in the book, Nelkin paid attention to the relationship between scientific journalism and public relations (PR). She observed that journalists and PR people have very similar skills, interests, and occupations and that there is a strong complicity with scientists and engineers. Scientific journalism and PR have an osmotic relationship, in which a person passes from one domain to the other while doing almost the same job. Her observation still remains completely valid today: the president of the Swiss scientific journalists' association wrote that journalism and PR cannot be separated (Dessibourg 2013). Moreover, looking back to the first decades of the present century, universities and research laboratories have – for many different reasons, including but not limited to the Shanghai ranking of universities which has been published since 2003 – hired more and more communication staff, including many scientific journalists. A competition heightened on the level of communication that had not previously existed.

In 1993, Ulrike Felt published the results of a study about high temperature superconductivity (HTS) conducted between 1987 and 1989. Widely cited, the article *Fabricating scientific success stories* is a comparative study of four countries in which this field of physics has been established. Press coverage in these four countries is counted up and its content analyzed. The article starts by interrogating the relationship between science and society as they looked in 1960 and in the early 1990s:

> Science meets the public under radically altered conditions: communication and trust, credibility and authority, support and cultural meaning are no longer what they used to be. (Felt 1993, 375)

What is the point of the paper? It seemed to Felt that "no scientific discovery [...] has given rise to such a wave of enthusiasm," and that "stories" were told about "fundamental breakthroughs" and "technological dreams..." (Felt 1993, 377). A physicist articulated an interpretation of

what was happening: "he puts the blame for what he sees as misjudgment on the part of US science policy makers and on the distortion by media-hype...". He explained the scientific success story as the result of a "joint venture between some scientists and breakthrough-hungry journalists", considering it "an aberration" when compared to many other advances in postwar physics (Felt 1993, 377).

The comparative study goes on to present Felt's insights: the domain of physics to which HTS belonged was under "severe financial pressure," and "scientists hoped to gain visibility in the public domain to show the relevance of their research," thus "put[ting] pressure on policy makers and funding agencies" (Felt 1993, 387). The number of press reports and public visibility "could be turned into valuable negotiation capital when competing with others for money." For policy makers, in turn, fabricating success stories brought advantages: it provided them with a better foundation for setting funding priorities and legitimizing their decisions in an increasingly competitive context. I intend to show that the relations described here between science, the media, and science policy are on the verge of turning into a regime whose operating speed will only increase.

What were the reasons for the large differences in press coverage in the nation-states compared in the study? In Switzerland, where in 1986 an important discovery in superconductivity physics was made at the IBM lab in Zurich, in Germany, home to one of the two Nobel prize winners, and in Austria, "there was no perceived need to inform a wider public" (Felt 1993, 388). In these countries, the press did not at all tell the same story, being much more interested in technical details, and "played far less with speculations on future applications." In the US, by contrast, "most universities are aware [...] they get public money and therefore need the support of a broader public." The press in the US thematized international competition, especially with Japan, so that stories of "technological dream and fiction were sold." The conclusion, evoking Nelkin's book, is that:

> In a climate of fierce economic competition, in a time of stagnating budgets and confronted with a public that is constantly facing the consequences of science and technology, "selling science" cannot be regarded as a luxury any more – it has become an obligation. (Felt 1993, 389)

The value of this study, especially when compared to traditional media studies, which counts occurrences without considering actor networks, is that Felt focuses equally on the research and decision-making milieus. Her conclusion goes against the dominant and naive view that only journalists exaggerate scientific prospects, telling stories, while the scientists themselves are precise and neutral.

4. The Market of Promises and the Sociology of Expectations

Arie Rip pioneered the sociology of expectations, as one of the first researchers, at least in Europe, to pay attention to science policy and funding agencies (Rip 1994). He directed the PhD thesis of Harro van Lente, who is often associated with the beginnings of this field (Van Lente 1994). Van Lente forged the concept of the *promise-requirement cycle,* and was followed by colleagues who developed other basic concepts, mainly those of the *situatedness* and *performativity* of promises (Brown et al. 2000; Brown 2003; Borup et al. 2006). At the end of 1990s, the sociology of expectations literature was about to deploy. This development had to do with the amplification of the economy (or market) of scientific promises.

The sociology of expectations explains that hype, fiction, and stories of distant futures are primarily aimed at stakeholders in research and innovation: i.e., scientific policy makers, scientists, engineers, innovators, business managers, venture capitalists, and early users. Performativity supposes that promises do actually influence stakeholders' behavior towards the envisaged technology and looks at the means used to achieve influence. One privileged way of influencing is to articulate "rhetorical devices," for example about the inevitability of competition and progress, and to circulate "compelling narratives" (quoted in Sand and Schneider 2017, 20) like a "forceful fiction" (Van Lente and Rip 1998).

As a conceptual framework, the promise-requirement cycle works well for analyzing individual promising endeavors, as well as broad emerging domains. A future vision protects a technoscientific endeavor for a certain time, granting it some credibility. A promise is like a shared belief, creating some space for a domain to progress and to secure research or R&D (Ruef and Markard 2010). Eventually, however, a requirement must be fulfilled: there must be some concrete result. It can be far from what has been promised, as long as it is convincing enough for a new round of funding. Cycles of funding may go on or, if no results are reached, end.

Xeno-transplantation, gene therapy, the human genome project, biofuels, stem cells, synthetic biology, personalized medicine, nanomedicine, brain sciences, neurotechnology, wearable sensors, blockchain technology, autonomous vehicle, cultured meat, etc., have all followed such cycles of promise-requirement. The sociology of expectations allows us to analyze emerging science and technology in an alternative way to the popular hype-disillusionment curve, a tool developed in the 1990s by the Gartner company for bench-marking innovations, which, however, organizes, and takes part in, the market of promises (Pollock and Williams 2010; 2016).

Emerging technosciences often need a period of sustained promising before acquiring their own impetus. Referring to biotechnology in general, and genetically modified organisms and nanotechnology in particular, Joly states that promises pass *tests of credibility* (2010; 2015). These can occur either following an R&D event or an incident on the market, or

due to a lack of alignment between the actors, or because the technology is contested, or simply because of the time that has passed without significant advances. Sometimes hype rebounds, while in other cases the result is a cold shower, as happened to the bold promises of gene therapy in 2000. When concrete results do not meet expectations, the promissory field in most cases retreats from the spotlight. Although it seldom disappears completely, it attracts far less enthusiasm and money, leaving stakeholders with their belief and lost investments in the venture. Usually, nothing highly problematic happens in these cases, which are probably much more numerous than those ventures that eventually reach the market. Nobody can be held accountable for those promises that are not delivered on, except in rare cases where patients have been misled, for example, or fraud is proven, as in the case of Theranos which led to the conviction of its managers.[2] This case has shed light on the methods of promising used in Silicon Valley, as summarized by the popular positive-thinking aphorism "fake it till you make it."

The sociology of expectations investigates the market of scientific promises and highlights that future visions do not merely accompany scientific and technological development, but are a part of it. They play various roles, such as creating excitement, orienting, coordinating research efforts, and drawing road maps. Hype can be fabricated, sustained if necessary, and revamped if it has vanished (Audétat et al. 2015).

Nevertheless, the framework of the promise-requirement cycle, together with the concepts of performativity and credibility, does not always work. Indeed, there are cases of promises which do bring results, but which are either not attractive enough for venture capitalists or bother vested interests, and are thus abandoned after one or two rounds of funding (Parandian et al. 2012). Meanwhile, although they fail to bring promised breakthroughs, credibility and money continue to be granted to certain emerging technologies, as if there is no requirement to deliver, or more precisely, as if that obligation could perpetually be postponed. These expectations appear to have a second, third, or even eternal life, although their plausibility is sometimes far from being established.

The lesson of these cases is that finance is to some extent the master of the game. But they also show that the game, i.e., engaging in new endeavors then picking the winners, does not exactly work this way. Promise-requirement cycles are also conditioned by how much popularity promises manage to attract. Popularity here is connoted neither positively nor negatively, in the sense of reflecting either enthusiasm or concern. Simply put, the more popular a promise is, the more compelling it is for stakeholders. Thus, another arena is in play, just as critical as finance, which has to do with the performativity and popularity of promises in society, i.e., which includes, and goes beyond, actor networks. This arena, which is mainly located in the media sphere, connects with cultural representations and the true power of myth.

5. Nanotechnology, or the "Regime of Promising"

Promising technosciences have proven to be highly speculative and attracted growing attention. A threshold was crossed when nanotechnology started to be advertised following the adoption of the US Nanotechnology Initiative (2001). Fantastic stories of the future, mixed with the discourse of transhumanism and fostering human enhancement, left many stakeholders uneasy, especially in science (where people have informed views about feasibility and different opinions about the ethics involved in promising) and European science policy. The sociology of expectations developed further, and STS specialists were "hired" by decision makers in the EU, who did not know how to react other than by funding nanotechnology to stay competitive. Attempts to discuss with science policy makers and stakeholders, and to engage more responsibly with the public, resulted in a report to the EU Directorate of Research (Felt and Wynne 2007), in which the "economy of technoscientific promises" was subject to discussion and counterbalanced with an alternative possibility called the "regime of collective experimentation," in an effort to create more commitment and engagement with European society. The EU finally responded with guidelines for "responsible research and innovation," sidelining the 7th Framework Programme of Research (2007-2013).

Questions were asked and the word "plausibility" was in the mouths of many when the bold discourse about convergence at the nanoscale, nano-machines, and connecting brains with machines and brains with brains (Rocco and Bainbridge 2002) was promoted as an absolutely certain future, as only a matter of time (Schummer 2010). Speculation about future technological achievement has often been found to be completely disconnected from what was actually going on in laboratories. Technical plausibility could be understood as an arena of negotiation of trust and credibility, while societal plausibility opens discussion about the desirability of certain technoscientific developments (Selin 2007; Lucivero 2016). The concept of *anticipatory governance* was elaborated in order to open space and provide methods for deliberation and assessment between stakeholders and society (Guston 2012; Konrad et al. 2016). Nonetheless, the ethics of promising came to be seen as completely unbound – with nanotech being only one particular case – and matters of principle were raised for discussion, for example, whether running ethical, legal, and social impact studies (ELSI studies) on technology whose plausibility was still in question was not granting it credibility (Nordmann 2007; Sand and Schneider 2017) and diverting technology assessment from more concrete and urgent issues.

With the umbrella term "nanotechnology," another direction in the sociology of expectations has been explored following the observation that "struggle for meanings"[3] was taking place, opposing quantum physics to chemistry, bionano, micro-mechanics, neurotechnology, and so on. Every domain of science wanted its piece of the cake, producing "nano-

narratives" (Milburn 2002), with the result that "folk theories" (Rip 2006) circulated on a massive scale in a kind of competition of speculative science.[4]

In short, the "economy of promises" became an issue in itself. The term came to be used by many people to describe what they had to deal with. Richard Jones, a British physicist involved in science policy, who engaged as much with the scientific and technical debates about nanotechnology as with its societal implications, was among the first to talk of an "economy of promises" (Jones 2008) and started a blog in 2004 in order to promote informed debate.

It is important to note that the claim here is not that present scientific expectations are more fantastic than past ones. For instance, from the 1960s to 1980s (or later), it was thought certain that science would always provide new solutions to production problems or societal challenges. Energy production, which was seen as an exemplar, was said to be ever increasing at ever-decreasing costs. New modes of energy production (e.g., nuclear fusion, anti-matter) would continue to be discovered and exploited. It was believed that this logarithmic progression would go on until the point when an infinity of energy could be produced for free. It is hard to believe today. At the time, though, the industrial world was at the tail end of several decades of economic growth. This example is meant to show that future visions of technoscience should be understood in relation to the economics, society, and environment of their time. As such, past visions of the future are not less or more fantasies, or phantasma, than contemporary visions like "convergence at the nanoscale" or the "singularity." These examples also tend to show that plausibility is perhaps less important than – albeit a part of – the promotion of a certain technoscientific imaginary.

A touchstone of the architecture of the sociology of expectations was the formulation of the definition of *socio-technical imaginaries*: beliefs "collectively held, institutionally stabilized, and publicly performed visions of desirable futures..." (Jasanoff and Kim 2015, 6). Although "desirable futures" may not necessarily be the case, as we shall see, the value of this definition is to state that the condition is to be shared across various milieus, including in the public – meaning beyond stakeholders' circles, beyond actors' networks, which pushes this sociological enquiry into new areas.

The meaning and definition of the term *regime of promising* was forged by and with Arie Rip. To begin with, the word "expectation" is perhaps not entirely convincing for the object of study. On the one hand, it is good for potentially encompassing all kinds of horizons of expectation, including those of stakeholders and those of citizens. On the other hand, it has a passive meaning. The term "pro-spect" might be better: "prospecting" meaning "looking forward" in Latin, indicating an active bet on the future. Indeed, Brown and colleagues speak of "prospective techno-science" (2000). This is perhaps a reason why the word "promise" came to be used more frequently. Moreover, the adjective "promissory" is

a quality attributed to something, while the verb "promising" indicates what proponents are doing and aiming at.

We came to speak, with Arie Rip, of a regime of promising for the speculative market, standing above research and innovation, which has consequences for the whole research system, for academia, and from which no discipline is protected.[5] For domains of science actually not perceived as competitive enough, the situation has often become "promise or perish" (Audétat et al. 2015). In Rip's view, a regime is not an institution: it holds as long it is fed by various flows coming together. It follows that it can break or collapse if one flow – or all flows – diminish, if trust disappears. Rip wrote an "STS fiction" about how this could happen in the near future, sketching a change in science policy that now asks for proof of concept before funding, prioritizing translational research, after a dramatic decrease of trust in the current system of scientific reputation and allocation of money (Rip 2015). Another proposition, coming from French scientists disgusted with the competition and the percentage of projects granted against the total number of applications (13-17%, according to estimates from the 2010s), would be to grant research funds by lottery. Competition in promising would decrease; fairness would improve.

The flows feeding the regime of promising are: 1) financial, the money granted to research on a competitive base; 2) scientific, the number of researchers applying for funding; and 3) communicational, the appetite in the media for technoscientific breakthroughs and future visions. The regime of promising technosciences results from an increase in competition at all these different levels. Global competition for technological leadership became more intense when China entered the game as a new player around the turn of the millennium. The term of "knowledge economy" has been used in the EU Lisbon Agenda (2000) as an answer to this perceived elevation of competition. More money has been granted to competitive technosciences, like the Flagship scheme, granting about a billion euro to promising fields. The Human Brain Project, as well as Graphene, obtained such strategic funding after, literally, campaigns of promising. Another competition, in addition to that between nation-states, is the one between different promising fields of technosciences, as well as within individual fields. The third type of competition which is added to these two takes place in the media sphere. It is perhaps this latter battlefield that is least well understood. The sociology of expectations is mainly interested in the functioning of visions, promises, and imaginaries within science policy and innovation systems, and less in the massive circulation, rewriting, and popularity of socio-technical imaginaries, including their cultural meanings. The bridge between STS and cultural studies always existed, although the linkage of popular culture with promises and innovation, as, for example, in Magaudda (2012), remains too rare and is to encourage.

6. Storytelling and the Economy of Attention

Yves Citton originally came from the field of arts and literature, later becoming a media sociologist who caused an earthquake in this field in the French-speaking world with *Mythocratie* (2010), *Pour une écologie de l'attention* (2014), and *Médiarchie* (2017).[6] Citton traces back the concept of the economy of attention, explaining how it came to dominate the media and cultural spheres. The concept is much older than the Internet, although it really became critical in relation to it from end of the 1990s. The economy of attention then rapidly came to be considered critical to work in and understand the digital transformations taking place in the media sphere (Citton 2014).

The basic idea of the economy of attention is that, for example, when it comes to the number of movies you can go watch downtown or at home in front of your television, or the number of novels published every year, it is simply impossible to pay attention to everything: the offer very much exceeds what you can watch or read. Any economy relies on resources, and in this case, the rare and limited resource is the attention an individual can pay each day, or week, which can by no means be increased or multiplied above a certain ceiling. With the globalization of access to the web, since the emergence of mp3s, YouTube, online video games, social networks, and more recently streaming platforms, the information and cultural goods available have increased manyfold, whereas the resource of attention has remained the same. As a matter of consequence, attracting attention became the main struggle for any informational or cultural product. The competition has only become fiercer and fiercer.

A whole business developed, very much centered on advertising professionals, which is concerned with how best to capture attention, maintaining it, creating addiction. According to Citton, at the turn of the millennium politicians, communicators, and managers discovered a treasure: storytelling. Storytelling came to be the privileged mode of communicating anything. Recipes and toolboxes multiplied that were aimed at helping advertisers, web managers, and business managers learn how to attract attention, notably through storytelling.[7]

As mere consumers (which we all are), it was difficult to understand why more and more things were made available for "free," and how so many costly informational services became "free," but we became accustomed to accessing things for "free." Of course, advertisement was there to explain part of this strange new economy – although it was difficult to understand all of its implications, until the following saying started to circulate widely: "If something is free, then the real product is you." So, nothing is for free: we are paying with our attention. It started to become clear that accumulating attention was equal to accumulating capital. The way in which the economy of attention has unfolded has numerous consequences, including for the print press and the public sphere as a whole.

It became a matter of survival for musicians, authors, journalists, and filmmakers. Since then, all cultural goods struggle to be noticed. Science and technology were subjected to the economy of attention as well, and promising conformed with these trends by producing catchy images, stories, and videos personifying desirable futures. SF writers and social scientists were asked, if not hired, to contribute to creating stories and writing or filming about how life would look in the future thanks to technosciences (Milburn 2002). The old scientific ethos of distancing oneself from common sense and the media was completely turned upside down. Even protected by its own rules, academia is subject to these trends determining how to stay afloat in the ocean of available (scientific) information. This generates bias. Take, for example, the two Stanford scholars who, in 2017, presented themselves as whistleblowers, warning that deep learning can now guess people's sexual orientation by analyzing their faces and thus determine if someone is gay (Baya-Laffite et al. 2018). Part of the explanation is that breaching ethical conventions has been a way to come to the fore, to get noticed and quoted.

Mythocratie, the title of Citton's book, is meant to speak to and restore the power of myth, the power of stories. The targets of stories are desires, values and identity – all dimensions that Citton collectively refers to as "affects," i.e., as what moves people. An individual's personal story, which facilitates identification by the audience, is central to these strategies. The rules of telling a story efficiently or touching people's emotions, together with all the tricks to attract attention, are about mind control. Yet, were the technosciences sheltered from the economy of attention? By no means. In fact, promising itself has been subjected to it, and pushed further and further by fabricating successful breakthroughs, promoting champions, and visioneering. Scientific expectations require the broadest possible popularity in order to influence stakeholders. Thus, the regime of promising may well have been shaped by the economy of attention, eventually explaining "why so many promises."

7. "Half of All Jobs Will be Automated by 2034"

Recalling the classroom dialogue reported at the beginning, let us consider how the story of job replacement by machines started, unfolded, and then calmed down. Around 2012, excitement was triggered by various mathematical paradigms and methods that were competing in the algorithm industry. Neural networks – a paradigm dating back to the 1960s that had been developed during the 1990s, before being left aside by industry in favor of statistical methods – were resurrected by computer scientists prior to 2010. Neural networks allowed automatic translation to achieve better percentages of correct matches against other more cumbersome methods relying on databases and heavy statistical work. Research-

ers also found that graphic cards (GPU) made for computer games can run neural networks.[8] Whether the return and take off of neural networks represented a breakthrough or was the result of continuous improvements remains controversial in computer science (Pasquinelli 2019). It has, however, been presented as a breakthrough and the term "deep learning" has been popularized as a metaphor for truly abstract mathematical work.

Just as the enormous hype about the "third spring of artificial intelligence" was gaining steam, two economists at Oxford University published a study conducted with the help of an algorithm about the impact of AI on the job market. Their aim was to investigate the probability of jobs being automated. They based their study on expectations concerning the combination of AI and mobile robotics. They took into account the prospects of algorithms being capable of equalling or exceeding humans in performing tasks, based their estimates on the skills machine learning was expected to attain, and took for granted applications envisaged as likely to be industrialized, like self-driving cars or holding a conversation. Then, they considered the many tasks included in jobs (whether routine or non-routine) that AI could theoretically do. They took for granted that algorithms can perform without human error and that they are by definition unbiased. They also excluded tasks entailing what they called emotional, creative, or social intelligence. They then turned to a US list of 900 occupations whose description is detailed, standardized, and kept up to date, finding that 702 were suitable for submission to the algorithmic method of probabilistic analysis. By the way, they made the classic mistake of confusing work and employment, concluding that many jobs in agriculture, industry, and especially in the service sector, like transportation, sales, call centers, accountancy, cleaning, household chores, food, mail, healthcare, etc., were threatened by AI and robots. Their computational method resulted in an estimate that 47% of US jobs were at risk of being automated in the near future. The resulting article was M. Osborne and C.B. Frey, "The Future of Employment: How Susceptible Are Jobs to Computerisation?" published in September 2013.

It took some time for the study to hit the headlines, beginning (perhaps) with the *Huffington Post* publishing a series of articles: "About a 50/50 chance a computer threatens to steal your job: paper," and "47% of all jobs will be automated by 2034, and no government is prepared says economist."[9] A few weeks later, the quote appeared absolutely everywhere: in the press, in online media, on television, and on social networks. It created one of the biggest buzzes of all time. If we could model its diffusion day by day over a few months and count the number of quotes, we would see a chain reaction. The story of job replacement soon reached everybody.

The Osborne and Frey study gave rise to escalating announcements, predictions, and simplifications, with a particular appetite for the disruptive impact AI was supposed to have on employment and society. To name just a few examples, in 2015, Merrill Lynch Bank:

> predicted that by 2025 the "annual creative disruption impact" from AI could amount to 14-33 trillion $, including [...] 8 trillion $ reduction in employment costs in manufacturing and healthcare.[10]

McKinsey Global suggested that by 2030, intelligent agents and robots could replace as much as 30% of the world's current human labor, from 400 to 800 million jobs, and that the transformation of society is "happening ten times faster and at 300 times the scale, or roughly 3,000 times the impact" of the (classic) Industrial Revolution. Some voiced their belief that 99% of all jobs would disappear. A modest study came to conclude that there is "a 50% chance of AI outperforming humans in all tasks in 45 years." (Grace et al. 2017).

With these announcements, anybody can construct his or her own story about the future of employment and society. Indeed, many people entered the game of prediction. For example, Yuval Harari (the author of *Sapiens*) wrote in *The Guardian* that "by 2050 a new class of people might emerge – the useless class, people who are not just unemployed, but unemployable."[11] In the French media sphere, for a couple of years, a physician assumed the role of a techno-prophet announcing the darkest-possible future. There was not a single day that he did not appear in the media. L. Alexandre especially targeted the education system, declaring on Swiss television that "schools are teaching pupils who will be wrecked by AI."[12] That was a few days before I came to the high school and heard the echo of this dark prediction in the mouth of the pupil.

More cautious studies about the prospected impact of AI on jobs have been conducted and published, but their voices could hardly be heard. For example, in 2014, the Pew Research Center published an expert's predictions that job loss was being balanced by the job creation resulting from AI and robotics, but its media impact was close to zero compared to Osborne and Frey, most probably because there were no striking results or figures. The excitement about the disruption of employment prompted many countries, think tanks, and research institutions to conduct studies on the same topic. Schlogl et al. examined about 200 reports about "the future of work" published between 2013 and 2018, two-thirds issued in 2017 and 2018 (Schlogl et al. 2021), i.e., directly as a consequence of the buzz created around AI that the study of Osborne and Frey contributed to. Unsurprisingly, the main generators of that kind of promising are big tech corporations. For four years, the hype around AI, which eventually attracted investment, pressured all countries to come up with a strategy in order to compete. It performed dominantly in the dystopian genre.

8. Why Have Pessimistic Promising of Disruption and AI Performed So Well?

A phenomenon already observed in relation to promising concerning nanotechnology (and other emerging sciences and technologies) is that many computer scientists felt uncomfortable with storytelling that was supposed to support their field. In the media, many experts have been saying that all this excitement is merely speculative. But it took time before it was possible to hear the more cautious voices. Again, to name some examples, experts stated that the idea of a "general artificial intelligence," which would make machines capable of competing with any kind of human agency, is groundless (Pasquinelli 2019). But the idea stimulates people (including computer scientists) to tell imaginative stories about the future. Reacting to the Osborne and Frey study about job losses and other prophecies, Rodney Brooks, a pioneer of AI, wrote an article entitled "The Seven Deadly Sins of AI Predictions: Mistaken extrapolations, limited imagination, and other common mistakes that distract us from thinking more productively about the future."[13] François Blayo, a professor in computer sciences and AI at the technical university HEIG-Vaud, in his address to a diverse audience, began by saying "Please, calm down."[14] Zachary Lipton, professor at the machine learning department at Carnegie Mellon University, has stated:

> […] people are afraid of the wrong things. [...] There are policy makers earnestly having meetings to discuss the rights of robots when they should be talking about discrimination in algorithmic decision making.

and concluded that:

> […] the interest in "machine learning" and "deep learning" has led to a deluge [...] of misreprentation of research for the purpose of generating retweets and clicks.[15]

Although disconnected from computer science, the story of robots taking all the jobs, that of general artificial intelligence, like that of colonizing Mars, indicate that plausibility is less important than the building of an imaginary in the population.

In March 2018, a series of events put an end, almost overnight, to this period of unbound hype and techno-prophecy. On March 18, an autonomous vehicle in trial by Uber killed a woman crossing the road at night in Tempe, Arizona. Other lethal accidents involving the use of the autopilot device in Tesla cars were then reported. The Cambridge Analytica scandal, although already known by a few people, aired that same month in 2018, revealing the malpractice that played a role in the Brexit referendum of June 2016, as well as in the election of Donald Trump in November of

the same year. Subsequently, the promising of AI, and especially the tone of disruption and dystopia calmed down. The number of references in the media sphere to self-driving cars, AI, and the job market dropped. More reasonable voices started to be heard. An OECD report that same year came to conclude that only 9% of jobs in the US were at risk, while 32% were at risk of important changes in relation to automation. A new study by McKinsey conducted in December 2017 concluded that, at around 2030, rather than a loss, there would be more likely a 14% increase in jobs.

Explaining "why pessimistic promising of disruption performed so well" requires us to go back to the previous decades. From the 1960s to the mid-1990s, economic growth and competitiveness was almost the sole justification given for funding technoscientific research, until one day this discourse centered on economic benefits went flat, no longer performing in a competitive environment. A need was felt to re-enchant the scientific endeavor, which could help emerging science and technology to create excitement. At the end of the 1990s, when struggles to attract attention became more severe, grand stories of technoscientific future made a comeback. Through the promises of eliminating non-infectious diseases, curing cancer, anti-aging, convergence at the nanoscale, etc., promising was turned toward a bright future. But after some time, it perhaps became too bright to be credible anymore. Therefore, bright futures have been overshadowed by more dramatic ones, futures of disruption, according to the new vocabulary of Silicon Valley. Disruption, which goes together with a dark future, became more attractive and more credible in the economy of attention. Performing with pessimism became the better approach, speaking of dramatic impacts on jobs, rather than repeating that technoscience will find solutions to everything. After nanotechnology and human enhancement started to lose popularity around 2010, venture capitalists and other stakeholders were glad to turn to societal disruption and AI.

At the same time, a TV series understood better than anybody what was happening. *Black Mirror* premiered in 2013 on the UK's Channel 4. Perhaps in opposition to nanotechnology, which hardly materialized in daily life, the smart phone, together with the algorithms directing advertisement that everybody experienced, was already making AI concrete. The success of *Black Mirror* shows that creating scenarios can serve different ends. In the case of the TV series, writing scenarios of anticipation that put technosciences at the center can result in very attractive and thoughtful entertainment. The promises of technosciences and future visions are performed by and for stakeholders, but at the same time, they acquire a life of their own in the media and cultural spheres, which then takes part in stabilizing or contesting socio-technical imaginaries.

The question then arises: do stakeholders and other individuals believe in the technoscientific promises they are exposed to? The verb "believing" is problematic, since it is still associated with religious truth and revelation. To understand what is at stake here, one should turn to theory

of representation in the arts. It is important to see, first of all, that people are not passive receptors of promises. On the contrary, there is always an act of reading implied. In light of differences, individuals may ignore, reject, doubt, or buy a promising discourse. Stories do not merely circulate, since many people elaborate on stories and rewrite them, scenarising further. Yet, what happens when we read a novel (e.g., an SF novel) or watch a movie? Citton refers to the philosopher Kendall L. Walton, the author of *Mimesis as Make-Believe: On the Foundation of the Representational Arts,* published in 1990 (Citton 2010, 81). The theory of arts speaks of "suspension of disbelief," i.e., we suspend for a while our doubts and skepticism about reality and credibility, in order to get into the story. Crafting and reading stories are thus part of a game of "make-believe." Usually understood in relation to cultural works alone, the game of "make-believe" may well be at work in promising science and technology. Do people believe in some particular promising vision? In fact, people decide whether to take it or leave it.

9. Fiction as Method

From the lab to the market, the success of innovations is highly uncertain, which is one reason why, in order to secure funding, promising is often assertive and technoscientific futures presented in deterministic terms. This is why scientific promises are fictions, although presented as future facts. In Arie Rip's words, scientific promises are to be approached as a literary genre (personal communication). Fictions and stories are essential to introducing or attempting to stabilize a socio-technical imaginary, which in turn is paramount in order to drain investment. It explains that technosciences need so much to play in the economy of attention, i.e., "why so many promises". Meanwhile, the bubbling of technoscientific promises makes the future more opaque, exaggerated hype is misleading (Joly 2010). Therefore, fiction has to be taken seriously, from an analytical point of view, as well as a method of engagement – the latter in order to enlarge space where promises and visions can be discussed, their desirability evaluated or contested. The use of fiction is a method for countering this opacity and fostering a debate about what is desirable, possible, and a priority.

Citton forged two concepts that may be of interest for our purposes, that of *scenarisation* and that of "contre-fiction," i.e., *counter-fiction* (Citton 2012). He elaborates on scenarisation beyond its meaning of staging: whereas narration is the art of telling a story, scenarisation concerns how to meet desires, affects, values, beliefs, and ultimately how to influence behaviors. The news are not given "reality," but always a mix of fact and fiction (Citton 2010; 2012), and telling stories, controlling the stories in circulation, is critical for governing, making war, or preparing society for some change. In the domain of promising technoscience, scenarisation would be

the art of influencing behavior, above all of stakeholders, and preparing acceptance of technosciences throughout society. Scenarisation is to be seen as the continuation of the analysis of the performativity of promises.

Yet, to call into question fictions presented as future facts, one can produce fictions of another genre, counter-fictions. *Brave New World* was a counter-fiction to Haldane's vision of ectogenesis. Arie Rip's short story about how the regime of promising can collapse is a counter-fiction. *Black Mirror* is undoubtedly a masterpiece of counter-fiction. As Isabelle Stengers explains, following author Donna Haraway (1996), "we need new types of narratives."[16] Counter-fiction can take the form of a picture, a story, or an essay, of a movie or a documentary. Collective participatory scenario-building is another method. Since the social sciences have excluded thought experiments, SF literature has been the place for alternative and reflexive stories reacting to the dominant stories about technoscience, power, economics, environment, women, and colonialism. The SF genre is diverse, although a series of authors have openly endorsed this commitment theorized by Citton and Haraway, such as John Brunner, Ursula Le Guin, Norman Spinrad, Margaret Atwood, and today Alain Damasio or Octavia Butler (to name a few). Counter-fiction does not mean contesting the plausibility of promising technoscience, but rather opening the deterministic boxes it is usually contained in. STS should be able to model the diffusion of stories in the media sphere at the time of their occurrence, to conceive counter-fictional materials and scenarios, and to engage with the public, in order to allow a debate about what technoscience could be, or should be, and to help disentangle the future.

Notes

[1] For an in-depth historical, sociological, and philosophical account of the term "technoscience," see Bernadette Bensaude-Vincent (2009).

[2] *Le Temps*, September 3, 2021; *New York Times*, January 4, 2022; *The Guardian*, October 17, 2022.

[3] *The Struggle for Meanings: Representation and Debates in the Nanotechnology Field*, session convened by Arianna Ferrari, Andrea Lorenzet, Marina Maestrutti and Federico Neresini, EASST Conference, Trento, September 2-4, 2010.

[4] Nanotechnology promises were not all highly speculative. Some were in play closely connected to laboratory work. As an example, see Crabu (2014), who analyses a promissory object existing besides the bold promising of nanomedicine.

[5] A secondary meaning is conveyed by the plural "regimes of promising," referring to particular conditions found when a broad promise is translated into the particular conditions of a country, for example, or for differing conditions when speaking of green electricity or personal medicine for which specific system of innovation and accountability are found (Robinson et al. 2021).

[6] Citton also publishes in the associative multi-journals *Multitudes, revue politique, artistique, philosophique* (www.multitudes.net), which is meant as a continuation of *Futur antérieur* (1990-1997) created by Toni Negri and is inspired by the Italian collective of authors known as Wu Ming. It contains several journal's titles, where many different issues are approached without unnecessary disciplinary borders in the human and social sciences.

[7] Citton mentions as an example T. Davenport and J. Beck (2001) *The Attention Economy: Understanding the New Currency of Business*.

[8] Sussan R. (2014, December 31) *Le "deep learning" pour tous?*. Internetactu.net. http://www.internetactu.net/2014/10/02/le-deep-learning-pour-tous/.

[9] Strachan, M. (2013, September 14) Huffpost. https://www.huffpost.com/ entry/computer-jobs_n_3926922.
Rundle, M. (2014, January 17) Huffpost. https://www.huffingtonpost.co.uk/ 2014/01/17/rise-of-the-machines-economist_n_4616931.html.

[10] The Economist (2016, June 25) *The return of the machinery question*, p. 3.

[11] Harari, Y.N. (2017, May 8) *The meaning of life in a world without work*. The Guardian. https://www.theguardian.com/technology/2017/may/08/virtual-reality-religion-robots-sapiens-book.

[12] RTS Info (2017, October 3) *L'école forme des enfants qui vont être laminés par l'IA*.

[13] Brooks, R. (2017, October 6) *The Seven Deadly Sins of AI Predictions: Mistaken extrapolations, limited imagination, and other common mistakes that distract us from thinking more productively about the future*. MIT Technology Review. https://www.technologyreview.com/2017/10/06/241837/the-seven-deadly-sins-of-ai-predictions/.

[14] Blayo F. (2018, August 23) *Voyage au centre de l'IA*, Numerik Games Festival, Yverdon-les-Bains.

[15] Quoted by O. Schwarz (2018, July 25) *"The discourse is unhinged": How the media gets AI alarmingly wrong*. The Guardian.

[16] Isabelle Stengers, professor at the Université Libre de Bruxelles, and Fabrizio Terranova, director of the movie *Donna Haraway: Story Telling for Earthly Survival*, 2016, 77', invited at the Haute école de travail social (HETSL) and the University of Lausanne, February 6-7, 2018.

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Remaking Intelligence? Of Machines, Media, and Montage

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Abstract: Over the last decade, there has been a renewed interest in "artificial intelligence" (AI), notably in the form of "machine learning" (ML). This renewed interest may seem paradoxical, insofar as John McCarthy introduced the term "AI" in the mid-1950s to mark a distinction with ML, championing deductive reasoning over automated induction (e.g., Cardon et al. 2018). By contrast, the current reversal, towards ML-based forms of "AI," marks the statistical, if not spectacular, revival of automated induction. However, the terms used – revival, renewal, reversal – beg the question of the *common ground* of the involved alternatives. Taking its cue from recent historical (e.g., Penn 2020), relevant conceptual (e.g., Shanker 1998), and prior critical (e.g., Agre 1997) inquiries, this paper outlines a praxeological answer to the raised question. For the purpose, the paper develops a practice-based video analysis of a recent demonstration of "machine intelligence," the video demonstration of an "agent system" playing *Breakout* at "superhuman level," if not opening the gate for the advent of "general AI" (Hassabis 2017). In examining and engaging in "remaking intelligence" *in situ*, the paper dwells on the tricky interplay between machines, media, and montage, while making explicit and reflecting upon how particular configurations of "enchanted determinism" (Campolo and Crawford 2020) are staged and locally performed.

Keywords: artificial intelligence; breakout game; common ground; machine learning; practical reenactment(s); video demonstration.

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1. Introduction: The "Iceberg" Question – Is There a Common Ground to AI and ML?

In a recent talk on the intricate history of contemporary AI, a renowned sociologist elaborated on the paradoxical revival of "machine learning" (ML) as the currently dominant paradigm in the field, a field whose name – "artificial intelligence" (AI) – was precisely coined back in the mid-1950s to promote a deductive, rationalist paradigm to rule out prior empiricist efforts at inductive, example-based ML. Taking a historical stance, the sociologist paused on the argumentative pattern of the "perceptron controversy" from the late 1960s onwards, regarding the logical (im-)possibility of automated ML-based "image recognition" (e.g., Olazaran 1996), while interspersing his talk with epistemological considerations, among which the double meaning of "probability," statistical and psychological, as discussed in Hacking (2006[1975]). I hadn't read Hacking's book, *The Emergence of Probability*, but still needed to discuss the sociologist's argument, as the "discussant" of his talk[1].

Eventually, the talk I had listened to inspired me a question along the following lines:

> In his major work from 1983, *Representing and Intervening*, Hacking stages the controversy between Carnap and Popper in a long 30+ page introductory chapter only to conclude it, if I remember correctly, by the observation that their epistemological disagreement marks an Iceberg of common assumptions, notably their shared neglect of experimental practice, Hacking's topic. Hence my question: isn't there something similar going on in the history of AI? Doesn't the controversy between "deductive" AI, as pitched in 1955, and "inductive" ML, as pushed today, presuppose a common ground? What "common ground" is it? And how "deep" does it run?

In response to my question, I noticed a short silence, followed by a swift change in topic. The question, it seemed, had just triggered a "not now, not here" (Garfinkel 1975) phenomenon. In hindsight, the conspicuous silence may also be treated as constituting an inspiring starting point for multiple research directions, including the continuing challenge to write an encompassing history of AI/ML (e.g., Engemann and Sudmann 2018; Haigh 2021; Plasek 2016), the empirical interest of a "sociology of testing" in a field where the means of testing (e.g., data sets, algorithms, infrastructures) are often difficult to access, let alone replicate (Heaven 2020; Marres and Stark 2020), and a niche for "critical making" initiatives to tinker with, if not "rebuild" AI/ML-based systems (e.g., Bogers and Chiappini 2019; Lake et al. 2017; Sormani 2020). Rather than calling for a swift change in topic, the observed silence invites a sustained yet different line of inquiry, too[2].

This paper, accordingly, first pauses on the "Iceberg" question and two historical answers to it, material and conceptual, before explicating the alternative assumptions of its praxeological respecification (Section 2). On

this basis, the paper then develops a practice-based video analysis of a recent demonstration of "machine intelligence," the video demonstration of an "agent system" playing the game *Breakout* at "superhuman level," if not opening the gate for "general AI" (Section 2). In probing this video demonstration, an episode of "remaking intelligence" *in situ*, the paper dwells on the tricky interplay between machines, media, and montage, while making explicit how particular configurations of "enchanted determinism" (Campolo and Crawford 2020) are staged and locally performed. In conclusion, the praxeological respecification of "enchanted determinism" as a *situated* production will be reflected upon, as part and parcel the examined "singularity moment" (i.e., when the newly developed *Breakout* program was shown to surpass human play)[3].

2. Background: Historical and Praxeological Answers to the "Iceberg" Question

If the literature that traces AI/ML in terms of controversially opposed positions is well established, if not redundant (e.g., Minsky and Papert 1969), historical studies that chart their *common ground* and, in that sense, offer a history of "machine intelligence" seem to be rarer. This section briefly presents two such studies. On the one hand, *Inventing Intelligence* (Penn 2020) offers a richly documented inquiry into the material aspects shared by the founding figures of AI/ML in the USA of the 1950s and 1960s. On the other hand, *Wittgenstein's Remarks on the Foundations of AI* (Shanker 1998) clarifies the formal assumptions of Turing's program of "machine intelligence," the program that underpins the mainstream of AI/ML research (from the 1950s onwards, if not to the present day)[4].

Inventing Intelligence (Penn 2020) bears on the following "material aspects" of the joint emergence of AI/ML in the USA of the 1950s and 1960s:

- First, the major lines of research by the founding figures of AI/ML in the USA (including H. Simon and A. Newell, J. McCarthy, M. Minsky, as well as F. Rosenblatt) all relied on *military funding* – substantial, sustained, and at times unconditional. In one case (Minsky), the stop of unconditional funding allegedly led to the end of AI research (Penn 2020, 184-185).
- Second, and along with crafting (computer) code, these lines of research all implied *political sociologies* (Penn 2020, introduction). For example, H. Simon and A. Newell's rules-based AI took inspiration from a model of "rationalized administration" (cf. Simon's *Administrative Behavior* originally published in 1947), while F. Rosenblatt's probabilistically operating ML saw, not only in the abstract neuron, but also in the "free market" an inspiring analogy (Penn, ibid., Chapters 2 and 3).

- Third, the promise of "machine intelligence" seemed all the more realistic as the research teams by the founding figures of AI/ML all set out working with the same *mainframe computer*, "IBM 704" (Penn, ibid., p. 129), the company's first commercial computer facility that allowed them to variably explore and exploit the "novelty of computing as a digital medium" (ibid., p. 204).

Taken together, these aspects of emerging AI/ML research may be considered *material*, insofar as they facilitated such research "to get off the ground" in three respects at least: economical, ideological, and instrumental. Conversely, Shanker's book, cheekily entitled *Wittgenstein's Remarks on the Foundations of AI* (1998), clarifies the "formal assumptions" of AI/ML's common ground, Turing's program of "machine intelligence." For the purpose, Shanker leverages Wittgenstein's conceptual critique of Turing's program (as notably articulated in his 1937 essay). Each of Wittgenstein's critical points makes explicit one of Turing's assumptions, assumptions that may be listed accordingly:

- First, Turing's program of "machine intelligence" assumes the possibility of *mechanical reducibility* – that is, intentional conduct (such as "thinking," "calculating" or, say, "reading") is reducible to causal mechanisms, despite the normative terms (e.g., "rules," "norms," "reasons") that ordinarily characterize such conduct.
- Second, *computational complexity* is assumed to define intentional conduct as an emergent property – that is, there is a computable "learning continuum" from simple mechanisms to (human) everyday activities, "higher forms of learning [being] built up out of simpler components" (Shanker 1998, 65).
- Third, *mathematical formalism* is supposed to inform the mechanist reduction as well as the claimed emergence of intentional conduct, regardless both of the everyday use of mathematics ("in *mufti*", Wittgenstein 1956, Part 5, §2) and its normative character (i.e., in terms of "rules" or "subrules," not mechanisms or feedback loops).

Taken together, these *formal assumptions* of machine intelligence linger on in current forms of AI/ML as their common ground, at least as part of the common ground for their controversy narrative – for example, the idea of the "learning continuum" grounds both "ML" (as an inductive operation proceeding from "simpler components") and "AI" (as the deductively defined "higher form"). The same point holds with respect to the *material aspects* of AI/ML, insofar as current research continues to rely on substantial funding, ideological arguments, and/or instrumental infrastructure (for a recent study of continued military involvement, see Suchman 2022)[5].

Yet the regularly overlooked common ground does not tell us how it is drawn upon *in situ*, let alone how "enchanted determinism" (Campolo and Crawford 2020), as one variation or contingent imbroglio thereof, is performed via a technology demonstration. The open question points to the phenomenon studied in the next section. As a praxeological respecification,

the study homes in on the demonstration of a *Breakout* program playing at "superhuman level," while proceeding from two alternative assumptions. First, the study assumes the *irreducible practicality* of its situated phenomenon in the following sense:

> invariant rules [e.g., formal assumptions] and material elements can only account for the fact that the possibility of concrete sense-making [e.g., a technology demonstration] is conditioned and subject to limiting conditions. However, formalities and materialities are thereby not sufficient conditions, but only necessary conditions [for sense-making to take place], which always presuppose specific ordering work but do not explain it (Waldenfels 1985, 26; our translation).

Second, and in describing how the technology demonstration is done *in situ*, the study nevertheless assumes that something can be learned from the demonstration's practical accomplishment (the "specific ordering work" alluded to in the above quote) with respect to the *historical contexts*, material and/or conceptual, that it presupposes – be it to have them changed, re-instantiated, or modulated in a particular way. Praxeological respecification, in that sense,

> [does] not deny the historical and social "contexts" in which social action and interaction take place; rather, [it] insist[s] that specifications of such contexts are invariably bound to a local contexture of relevancies (Lynch 1993, 125).

3. Example: A Praxeological Study of/as "Remaking Intelligence" *In Situ*

> Each technique [in AI] is *both* a method for designing artifacts and a thematics for narrating its operation (Agre 1997, 135; emphasis added).

This section presents a practice-based video analysis of a recent technology demonstration, the video demonstration of a computer program playing *Breakout* at "superhuman level" (see Hassabis 2017, and note 7, below). Drawing upon the analysis, reenactment, and reanalysis of the video demonstration, the praxeological study engages with "remaking intelligence" *in situ*, both as a topic *and* a resource. The video demonstration, through the reflexive analysis of its montage, will be probed *topically* – that is, the analysis will show how the news announcement conveyed by the demonstration of the *Breakout* program – "it did this amazing thing, it found the optimal strategy" (Hassabis 2017) – relies upon particular configurations of "enchanted determinism" (Campolo and Crawford 2020). In turn, the reenactment of the video demonstration, drawing upon "remaking intelligence" *in situ* as a methodological *resource*, will allow us to tease out the "myriad of contingences" (Maynard 1997, 98) whose tacit mastery the

persuasive delivery of the news announcement relies upon. In so doing, the video analysis explicates how a particular genealogy of "machine intelligence" is folded into the video demonstration, while charting to what rhetorical effect its formal assumptions and material circumstances are deployed[6].

3.1 Analysis

In the video demonstration, Demis Hassabis, introduced as the "Co-Founder and CEO of *DeepMind*" (see shot 1), presents a computer program as an "agent system" and "AI" which, thanks to research and development (R&D) at the *DeepMind* company, has "succeeded in playing" *Breakout*, a video game from the late 1970s and early 1980s, at "superhuman level." How does Hassabis pitch his presentation? And how does his pitch appear convincing? *That* there might be a persuasion problem can already be gleaned from the vocabulary used to summarize the gist of the video demonstration. Indeed, the terms used – "agent system," "succeeded in playing," at "superhuman level" – all draw upon the questionable *formal assumptions* (i.e., mechanical reducibility, computational complexity, and mathematical formalism) and characteristic *material aspects* (e.g., a particular funding, organizational, and computing infrastructure) of "machine intelligence" – that is, as its necessary common, yet impossibly sufficient grounds. How then does the montage of the video demonstration solve (or dissolve) this persuasion problem? The transcript-assisted video analysis in this section offers a two-part answer to this empirical question. First, it examines how and what "ordinary circumstances" are configured for the news announcement to appear credible (3.1.1). Second, it takes a closer look at the "news announcement" itself by explicating its sequential organization (3.1.2)[7].

3.1.1 Configuring the ordinary circumstances of the news announcement

Breakout is at first sight a "highly straightforward video game" (Reeves et al. 2009, 207). Developed and marketed in the late 1970s and early 1980s by *Atari*, the video game has more recently become a test-bed for probing and improving ML algorithms, if not demonstrating "AI" as an emergent property of their successful testing. The video demonstration of present interest also relied upon this R&D strategy, a strategy whose (computer) scientific success had also been reported in a previous peer-reviewed publication (Mnih et al. 2015). Not all viewers of the video demonstration, let alone the documentary movie in which it figures, could and can be assumed to be computer scientists or regular readers of *Nature* though. Hence, the sole announcement of the *Breakout* computer program having "found the optimal strategy, which is to dig a tunnel" (see Excerpt 1, as indicated by white arrow) may fall short of its intended news value, as a convincing demonstration of cutting-edge AI, achieving "human-level control through

deep reinforcement learning" (Mnih et al. 2015) or somehow even going beyond "human-level control" (as we shall see shortly).

	DH*	**it found the optimal strategy, which=**
18 (2:45)	DH*	**+is to dig a tunnel** +((close-up shot on "breakout" game, with ball bouncing up and down between walls)) +((computer music gets faster)) ÄÄÄ… ÄÄÄ… ÄÄÄ **#18**

#18 ((close-up shot on "breakout" game, with ball bouncing up and down between walls))

Excerpt 1. News item in video demonstration, as stated by Demis Hassabis (shots 17-18). (Transcript prepared by the author)

As other performative expressions, news announcements only work under "ordinary circumstances" (Austin 1962, 52) as convincing communicative moves. The video demonstration may first be examined for *what* circumstances it (re-)configures and *how* it does so to convey its core message. In the transcribed fragment (see Appendix I), these circumstances are configured in familiar terms, as the autobiographical reflections of a successful entrepreneur, where the image of the latter (identified as "Demis Hassabis, Co-Founder & CEO [of] DeepMind," shot 1, video column) and the expression of the former (in the first person singular, "when I was a kid, I loved playing games", ibid., audio column) elaborate each other. Accordingly, Hassabis' arrival at the conference venue (at "Oxford University, UK," shot 2) is not only shown and told as the culminating part of his extraordinary career as a child prodigy (starting "off with board games like chess," having become the "Co-Founder & CEO [of] DeepMind"), but this culmination is also suggested to have been informed by a major insight all along: "computers were this sort of magical device that could extend the power of your mind" (shots 3-4). Taken together, these material aspects of "enchanted determinism" (i.e., regarding the male child prodigy turned successful contemplative entrepreneur) set the stage for the video demonstration of "machine intelligence" in the form of a particular news announcement: the *Breakout* program's "optimal strategy," if not its "potential for general AI" (shots 17-19)[8].

3.1.2 Drawing upon the sequential organization of the news announcement

To whom was the "news announcement" made, the announcement of the new *Breakout* program's performance at play? On the basis of the transcribed fragment (in Appendix I), two audiences can be identified: the intended audience of the documentary movie as part of which the video demonstration is shown (i.e., *AlphaGo. The Movie*, Krieg and Kohs 2017),

the audience present at Hassabis' Oxford University lecture which included the video demonstration of the new *Breakout* program to begin with (as shown in shots 7, 9, 10, etc.). A singular achievement of the movie's montage, then, is the production of a seamless articulation of scenes and sounds for these two publics to be addressed or at least shown to be addressed (a point we shall return to, see our reenactment and reanalysis sections below). In any case, the video demonstration addresses a broader audience (be it at home, in and/or via the lecture hall) than a specialist readership in science or computer science (e.g., as addressed by Mnih et al. 2015). How, then, does the documentary video's montage allow us, as a projected community, to:

> see through [our] cultural knowledge [and to] understand the filmic image and sequence […] in much the same way, and by reliance on the selfsame resources that we use to understand the perceptual world around us, a perceptual world of activity and interaction (Jayyusi 1988, 272)?

In answer to this question, the present section examines how the news announcement of the stunning performance of the new *Breakout* program – "it did this amazing thing, it found the optimal strategy" (Hassabis 2017) – was delivered. As we have seen, the entrepreneur's autobiography, if setting the stage for the news announcement, wouldn't be sufficient to convey it. In turn, the transcribed fragment (in Appendix I) allows us to examine how the news announcement of the program's "optimal strategy" is actually delivered, with particular reference to the interactional resources that the "sequential organization" of its delivery relies upon[9].

Notice that the news announcement in question is not only progressively delivered (audio column, from shot 9 onwards), but also shown as it is being fulfilled (video column, from shot 11 onwards). Moreover, the successive shots, organized in terms of as many "say-shows" (Garfinkel 2002, 177), articulate a particular "news delivery sequence" (Maynard 1997). From ordinary conversation, the sequence borrows its constitutive parts: an announcement, followed by its response, an elaboration, and a final assessment (ibid., p. 97). Yet the parts are not distributed as reciprocating turns at talk, as in conversation, but across the successive "say-shows" that compose the video episode.

Accordingly, the "announcement" is first stated ("so I'm gonna show you a few videos of the agent system, the AI," shots 9-10, audio column), for the viewer then to be enabled to reach a first "response," at home or in the local audience (as a male public member is shown to pay close attention (shot 10, video column)). The subsequent "elaboration," then, suggests that not only the "agent system has to learn everything for itself" (shot 12, audio and video column), but also that its performance, after having become "after three hundred games […] about as good as any human can play this" (shot 15), eventually surpasses human play by doing an "amazing thing" (shot 17) – that is, finding the "optimal strategy, which is to dig a tunnel" (shots 17-18, including a close-up, as shown in Excerpt 1 above).

Finally, and after having drawn laughter from the audience (shot 18, audio column), the "assessment" of the performance is left to the speaker (Demis Hassabis, as shown in shots 19-20) for contrasting qualifications – that is, as an expression of the limited *Breakout* skills of his "AI developers," on the one hand (shot 18, audio column), and the instructive "potential for general AI," on the other (shot 19, audio column).

Taken together, these interactive moves and their audiovisual montage foster "commitment evaluation routines" (Lampel 2001, 304), rather than a questioning stance or critical inquiry, regarding the presented technology and its discursive framing. In a nutshell, a second configuration of "enchanted determinism" is the manifest result (i.e., regarding the *Breakout* program's "potential for general AI," shot 19, calling for a "next step now," shot 20)[10].

3.2 Reenactment(s)

In the "perceptual world of activity and interaction," to use Jayyusi's felicitous phrase (1988, 272), conversationalists "shape each component [of a news delivery sequence] according to a *myriad of contingences*," as Maynard points out (1997, 98; emphasis added). The tentative reenactment of the video demonstration of the "singularity moment" – the moment at which the newly developed *Breakout* program was shown to surpass human play – allows us to tease out (some of) its critical contingencies – that is, contingencies which proved critical to articulating that news item in the first place (i.e., by Demis Hassabis, as shown in the Oxford University lecture hall, as staged and seen in the documentary movie). Yet different reenactments allow one to tease out different kinds of contingencies. This section presents three sets of them (see "reenactments A, B, C" below), before considering them as an ensemble of "tutorial problems" (Garfinkel 2002) for *reanalyzing* the initial transcript in the next section, including the "critical" or "incidental" character of the contingencies identified (i.e., as constitutive of the "ordinary circumstances" of the news announcement)[11].

3.2.1 The classic "home console" reenactment (A)

In 1983, the book *Pilgrim in the Microworld* was published, D. Sudnow's reflexive ethnography of playing *Breakout* at arcade halls and with home consoles (see Appendix II). As a later review puts it,

> Sudnow becomes his phenomenon: he hangs around arcades, plays the game with his children, and for long, long hours immerses himself in playing game after game of *Breakout*. His focus is on how an array of moves develop and build on one another through long-term play. (Reeves et al. 2009, 209).

Long-term play? In this respect, Sudnow's ethnography makes three interesting observations, as its author develops and deepens his "video skill" at and

with his home console (as a "re-enactment" of the video game as first observed to be engaged in by his children, friends, or other aficionados at play).

First, Sudnow's reflexive ethnography offers a succinct characterization of the *overall goal* of *Breakout*: "The overall goal, fat chance, is to eliminate the entire barricade until paddle and ball are all alone in empty court, victors" (Sudnow 1983, 35). Second, the book indicates the best *opening move* to reach that overall goal:

> the immediate object is to chip through to the open space on the other side, and once you've made this Breakout the ball rebounds like crazy between the far wall and the band [of bricks] […]. (Sudnow 1983, 34; see Fig. 1)

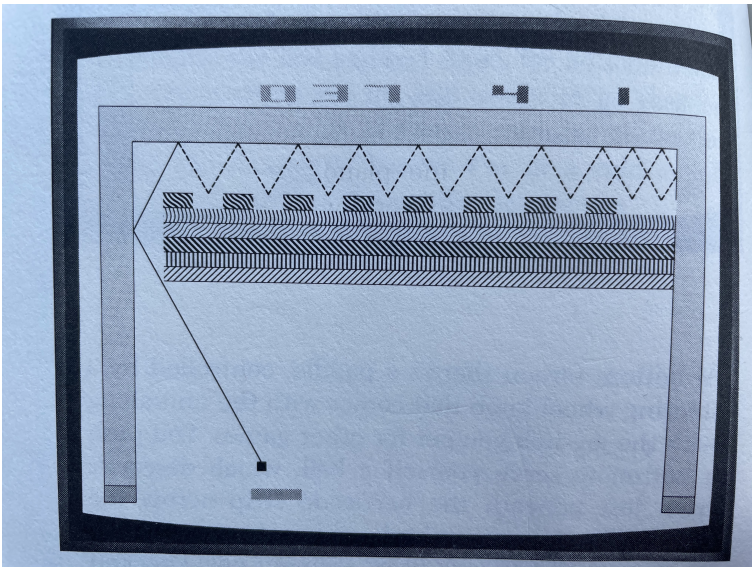

Figure 1. The best opening move in and for playing *Breakout*. (Photograph taken by the author)

Third, the book explains that the overall goal, despite or precisely because of sustained and skillful play, is often *not* reachable. "Lockups" are the result, which Sudnow describes as follows:

> With nearly nothing on the screen, the ball gets into a triangular pattern [sic] so immobile and regular you could take your hand off the knob [i.e., joystick], walk away for a week, and come back to find it just where it was. (1983, 85; see Fig. 2, ibid.)

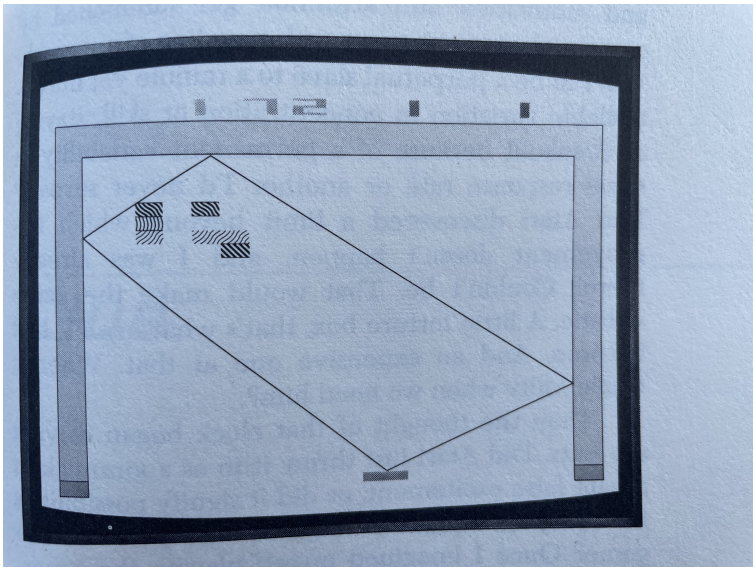

Figure 2. The unreachable overall goal in and of playing Breakout. (Photograph taken by the author)

Taken together, these three observations invite us to re-examine the video demonstration, its initial transcription (as to be found in Appendix I), as well as its transcript-assisted video analysis. Before doing so, let us consider two more recent reenactments of the video demonstration, however[12].

3.2.2 A contemporary "Zoom lecture" reenactment (B)

In a recent "Zoom lecture," I decided to reenact Hassabis' video demonstration by misreading its initial transcript as a roleplay script, while presenting the *Breakout* program to the remote audience by holding my laptop computer in front of the camera. The result: a deliberately "poor image" (see Fig. 3). Any lecturer with similar equipment could have done the reenactment, a possibility highlighted by the black-barred eyes (ibid.).

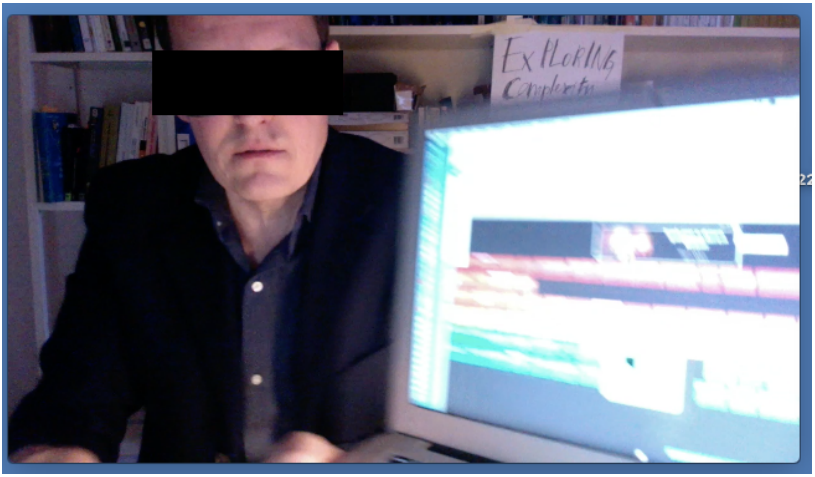

Figure 2. The "Zoom lecture" reenactment in and as its "poor image" (Steyerl 2010). (Screenshot taken by the author)

The laptop screen showed the *Breakout* program. I also had put up and redrawn the conference poster, entitled "Exploring Complexity," which was to be seen next to Hassabis during his video demonstration at Oxford. Some classic music found on the internet rounded off my "Zoom lecture" reenactment of Hassabis' demonstration. Both despite of and due to these practical efforts, my reenactment encountered innumerable problems of "say/show" coordination, some of which we shall draw upon in the reanalysis of the initial transcript, too (hence the allusion to the *deliberately* "poor image").

3.2.3 The museum "game station" reenactment (C)

At a local museum of cultural anthropology, I noticed that a *Breakout* "game station" had been installed (see Fig. 4 below) as part of its current AI exhibition. What for? The installation served two purposes at least. First, it offered a stepwise explanation of "reinforcement learning" by using the *Breakout* program as a paradigm case to illustrate the progressive improvement of such machine learning (that is, "from one day to another," rather than in terms of "hundreds of games"). Second, the installation invited its user to press "start" and use the "joystick" to play *Breakout*, if only to eventually contrast his or her expectably "slow play" with the rapid moves of the program (as shown during the "reinforcement learning" explanation).

Figure 3. The *Breakout* "game station" as installed at the museum. (Photograph taken by the author)

On both counts, the installation not only took its cue from Hassabis' video demonstration, but it also turned his persuasive argument into a lived experience, the lived experience of *failing* against the seeming superiority of the machine – that is, the *Breakout* program which was shown to master the game on-screen (as in Hassabis' demonstration) in contrast to the somewhat clumsy moves that were only possible to be played with the joystick due to its slow "reaction time" (as part of the museum installation). However, this and other handicaps proved heuristic, when it came to reanalyzing the initial transcript of the video demonstration.

3.3 Reanalysis

The news announcement of the computer *Breakout* achievement drew upon a sequential organization from ordinary conversation, while building upon the prior depiction of its "ordinary circumstances" (including the male child prodigy turned contemplative *DeepMind* CEO, his interested audience, the spectacular lecture hall, and so on). The ensuing reenactments of the *Breakout* achievement and/or its video demonstration had me pause on (some of) its/their critical contingencies. In what sense do they afford us with "tutorial problems" for reanalyzing the video demonstration? In answer to this question, it is worth revisiting the demonstration's initial transcript in the light of the encountered contingencies, if only to

assess the manifest contribution of their practical mastery to the video demonstration (e.g., "critical" or "incidental")[13].

What more is to be learned from Sudnow's reflexive ethnography of *Breakout* (A) on Hassabis' video demonstration? In a nutshell, Sudnow's classic "home console" reenactment challenges Hassabis' video demonstration both in its premises and conclusion. To begin with, Hassabis not only characterized "games [as] very convenient in that [many of them] have scores" (shot 7, audio column), enabling the "easy […] measure[ment] [of] incremental progress" (shot 8, audio), but also identified *Breakout* as an exemplar of this type of game. In turn, Sudnow's reenactment calls into question this twofold premise. First, Sudnow does not report his playing experience in terms of "incremental progress" (e.g., reaching an average player's skill after "three hundred games," shot 15), but as part of a uniquely qualifying situation (setting out with "one evening," Sundow 1983, 35). Second, if the "overall goal" (Sudnow, ibid.) of *Breakout* could be expressed by an optimal "score" (Hassabis, shot 7), that doesn't mean that this optimum can or could be "easily" measured, let alone reached. To the contrary, Sudnow's eventual mastery of *Breakout* led to "lockups," the repeated production of ball trajectories around remaining ceiling or wall parts still to be removed. A never-ending game was the result[14].

Returning to amateur play may then challenge the video demonstration's conclusion, the presentation of the new *Breakout* program as demonstrating a "potential for general AI" (shot 19). In turn, the presentation may be re-inspected for how it was delivered to make that conclusion plausible. This seems to have been done in three ways at least. Crucially, the opening move in *Breakout* as ordinarily played – the game's "immediate object" (Sudnow 1983, 34) – was cast as the program's *final* discovery – this "amazing thing […] it found the optimal strategy" (shots 17-18). Retrospectively, this discovery was suggested to be the result of "very easy to measure incremental progress" (shot 8): not only was the overall goal of the program simplified – from "eliminat[ing] the entire barricade" (Sudnow 1983, 35) to "break[ing] through this rainbow-colored wall" (shot 11) – but the pursuit of this simplified goal was shown to be "easy to measure" (in swiftly stated numbers of games played, shots 15a and 17a, and corresponding progress, shots 15b and 17b). Prospectively, the demonstrated discovery was suggested to have taught the "optimal strategy" of *Breakout* not only to the broader audience (via a close-up shot, see shot 18, video column, and Excerpt 1), but also to "amazing AI developers" themselves (shot 18), thus suggesting "potential for general AI" (shot 19)[15].

What more is to be learned from the "Zoom lecture" re-enactment of *Breakout* (B) and its "game station" installation at the museum (C), respectively? These two reenactments highlight two complementary sets of "ordinary circumstances" that the news delivery of the *Breakout* program and its "potential for general AI" hinges upon.

On the one hand, the misreading of the transcript as a script – to reenact the scene and setting of the *Breakout* program demonstration via a "poor image" (Steyerl 2010) strategy – cast into sharp relief not only that scene and setting as the background of this demonstration as its figure (including the "taxi ride" to the prestigious location, "Oxford University, UK," and the spectacular lecture hall), but also how the "figure-background" pair is assembled through its audio-visual montage: through a quick alternation of wide-angle and close-up shots (1-17), diversely accentuating the oral presentation, via multiple camera shots, and culminating in the close-up shot of said "optimal strategy" (shots 17-18). The montage, in a nutshell, both shows and dramatizes "the way things work from the inside" (Wieder et al. 2007, 249). Upon re-inspection, however, the quick alternation of shots also becomes of critical interest, insofar as it makes disappear the lack of diversity of the lecture audience (indeed, the audience seems to be composed of male members only, an arguably select "computer science" audience)[16].

On the other hand, the installation of the "game station" at the museum required its visitors and potential players to use the joystick to play *Breakout*. As I engaged in playing, the installation seemed to operate like a "one-way mirror." While it progressively produced the appearance of the *Breakout* program's transparent operation (as I was shown its improved play on the screen, similarly to Hassabis' video demonstration), the installation left in the dark how it entailed simultaneous player incapacitation (as my *Breakout* moves were made difficult due to the slowly reacting joystick). The latter provided an embodied, material condition for the former operation to become visible, if not credible. The initial video demonstration may be reexamined accordingly. While it draws upon the formal assumptions of "machine intelligence" (mechanical reducibility, computational complexity, mathematical formalism), the demonstration conspicuously leaves in the dark the material conditions for them to operate so transparently (i.e., as shown via the short video, demonstrating the excelling "agent system" via the simple *Breakout* interface, yet passing over the technical details of its operation)[17].

4. Conclusion: Beyond "Enchanted Determinism" – Yet Another Ambivalent Hybrid

This paper first reminded readers of the *common ground*, both conceptual and material, of AI and ML, a common ground that may be traced to Turing's program of "machine intelligence," on the one hand, and to the shared efforts of AI/ML research in the USA to engage in "(re-)inventing intelligence" via computer programming in the 1950s and 1960s, on the other. How is this common ground brought to play in a *current situation*? In answer to this question, the paper developed a practice-based video analysis of a recent demonstration of an "agent system" excelling at *Breakout*, the *Atari* video game from the 1970s/1980s, and thereby

potentiating "general AI" (Hassabis 2017). In addition to a detailed transcript, three *contrasting reenactments* of the video demonstration were drawn upon to explicate how its scenic plausibility was achieved. In the process, I described successive configurations of "enchanted determinism" (e.g., a child prodigy turned contemplative CEO, the agent system's "general AI" potential), while embedding the analyzed sequence of news delivery in its "ordinary circumstances" (e.g., an Oxford lecture hall, a simplified game, a select audience, mostly male). The praxeological description, then, suggested how the video demonstration of the new *Breakout* program framed its "deep learning" (or "reinforcement learning") achievement in the terms of lingering 1950s AI convention, both formal and material (e.g., a game-based "human-machine" comparison, in addition to the initially mentioned terms)[18].

However, the latter suggestion may be discussed further. Therefore, we shall reflect on "enchanted determinism" as a *situated* production – that is, as part and parcel of the peculiar "singularity moment" that this paper just described.

On the face of it, the presently analyzed, reenacted, and reanalyzed video demonstration of the *Breakout* program appears as a telling instance of "enchanted determinism," as indeed "magical mystery and technical mastery curiously work together" (Campolo and Crawford 2020, 4). Not only the initial allusion to computers as a "magical device [extending] the power of your mind" (shots 3-4) already nurtures this impression, but also the careful montage of the video demonstration suggests this conclusion, where the expression "careful montage" alludes to the persuasive demonstration of having the *Breakout* program appear as an "agent system" (shot 9), excelling at *Breakout* (shots 17-18), and showcasing the "potential for general AI" (shot 19). Indeed, the video demonstration borrows a longstanding framing of AI (i.e., the game-based "human-machine" comparison), while gesturing at its particular operation in terms of "machine learning" (ML, measuring the "incremental progress" from training session to training session, shots 12-18) with the help of a simple interface (i.e., the game interface of *Breakout*). Hence also the possibility of identifying multiple configurations of "enchanted determinism"[19].

Yet the observed multiplicity also hints at a more intricate genealogy of "machine intelligence" than its dualist AI/ML controversy narrative suggested, a dualist narrative which the notion of "enchanted determinism" seems to echo (if only insofar as "enchantment" presupposes its disenchanted opposite). Interestingly, this more intricate genealogy is to be found across STS and computer science. Indeed, not only the history of STS approaches to AI is full of ambivalent hybrids, *aka* "human/machine mixings" or "sociomaterial assemblages" (e.g., Suchman 2008), but so is the history written by AI researchers themselves – canonical (e.g., McCarthy et al. 2006[1955]) or critical (e.g., Agre 1997). The canonical project grouped diverse approaches to "machine intelligence" under the contested label ("AI"), while the critical approach teased out the philosophical rhetoric folded into technical practice(s).

Against this backdrop, the "singularity moment" described in this paper appears as the contingent introduction of yet another ambivalent hybrid – that is to say:

> the *general* intelligence that is put to test is modelled after a very *specific* and singular understanding of what human intelligence involves. It universalizes the idea of a player programmed into [a] 1980s Atari video [game] and restricts the task of an agent to outperforming this benchmark. (Bruder 2021, 80; emphasis added).

However, this peculiar hybrid not only confronts us with "a radically provincial idea of human creativity, intelligence, and ability," an idea borrowed from Western "video game design" (ibid.), but it also rehearses an older trajectory, trope, and trick:

> not one of rupture but of *remaking* – a [yet again] recalibrated "origin" of AI that re-contextualizes research fashions [e.g., "neuroscience"] in relation to local contingencies [e.g., video gaming]. (Penn 2020, 199; emphasis added)

– at least for now.

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Notes

[1] Empirically, the sociologist's talk was firmly rooted in digital data, reminding me of A. Rouvroy's nostalgic observation: "knowledge is not produced *about* the world anymore, but *from* the digital world. […]" (2013, 147).

[2] In the vein of recent IT developments, it has become common currency to pitch new types of ML (in particular "deep learning") against older forms of AI (prioritizing "intelligence simulation"), be it in terms of "human-aided" or "beyond human" types of ML (e.g., Fazi 2021; Mühlhoff 2020). For a longitudinal bibliometric study of the AI/ML controversy, see Cardon et al. (2018).

[3] In their recent paper, Campolo and Crawford (2020) introduce "enchanted determinism" as a sociological gloss to discuss the paradoxical rhetorical "enchantment" of ML (i.e., in terms of "magical powers" or otherwise unexplainable forces) *at the very moment* of its successful statistical operation (i.e., via determinate, if not deterministic, procedures of mathematical optimization). In turn, this paper examines the suggested paradox in and through the mentioned "singularity moment," while drawing upon prior work on technology demonstration (e.g., Lampel 2001; Reeves et al. 2016) and computer advertising (e.g., Aspray and deB. Beaver 1986). For a recent "state of the art," see Rosental (2021), and from a media historical perspective, Natale (2021).

[4] On the emerging domain, with a particular focus on the UK, see already Fleck (1982).

[5] In turn, Fazi's conceptual discussion of the "paradoxical condition of logico-mathematical abstraction" (2021, 70) in current ML systems, the condition of both relying on and going beyond human abilities of computation, echoes Wittgenstein's critique of Turing's program (see, again, Shanker 1998). Hence, "enchanted determinism" (Campolo and Crawford 2020), and "deceptive media" (Natale 2021) more specifically, may be understood as part of, and pragmatic responses to, that paradoxical condition.

[6] The video analysis, in addition to its transcript-mediated character, will draw upon reenactments of the analyzed demonstration below (in Section 3.2). This additional move defines the video analysis as a *practice-based* one, while making possible a reanalysis (see also Sormani 2016, 2019), if not a critique (e.g., McHoul 1994). Excerpts in this section are taken from and refer to the transcript of the video demonstration (in Appendix I). The video demonstration is included in *AlphaGo. The Movie* (Krieg and Kohs 2017), a documentary movie which showcases the development of *AlphaGo*, a successor program to the presently examined *Breakout* playing program (e.g., Binder 2021; Mair et al. 2021). Both programs were developed by Google-owned *DeepMind*, a London-based company specializing in "neuroscience-inspired AI" (Hassabis et al. 2017).

[7] The video analysis focuses on the *Breakout* demonstration as it is shown in the documentary movie (Krieg and Kohs 2017). For its initial presentation, as part of a *Nature* journal article and an invited lecture at Oxford University, see Mnih et al. (2015) and Hassabis (2016), respectively.

[8] As Hassabis is still shown to be arriving at the conference venue (shots 5-6, video column), his lecture is already to be heard (ibid., audio column). Why? Note that the initially audible part of the lecture follows his audible reflections in the first person singular. A smooth transition is thereby suggested between his autobiographical reflections on "board games," "computers," and so on (shots 1-4, audio column), and the R&D activities of the company that he has been shown (in shot 1) and will be heard to represent: "virtual environments and games […] we [at DeepMind] think they are the perfect platform for developing and testing AI algorithms" (shots 5-6, audio column). For further analysis along these lines, see Wieder et al. (2007, 254-255).

[9] This sequential organization appears to be a regularly used conversational resource in technology demonstrations – hence the possibility for the present analysis to draw upon prior analysis (e.g., Sormani 2019). Perhaps because of its mundane character, the sequential organization of news delivery has largely escaped the rich literature in STS on technology demonstrations (e.g., Rosental 2021).

[10] Instead of "focus[ing] attention on problems and limitations [or elaborating on factual information], *commitment evaluation routines* […] focus on the achievements and future potential of the new technology" (Lampel 2001, 304; emphasis in original). Conversely, one may ask: "But what form of intelligence is this" (Bruder 2021, 79)?

[11] Garfinkel's rationale for attempting to (re-)enact Galileo's "*inclined plane demonstration*" is worth quoting in this respect: "The experiment on which we report was set

up, not to figure out how Galileo's experiment did work but rather to discover what would make it *not* work, what contingencies would lose the phenomena. Because these would then be *[critical] contingencies* that Galileo would have to have taken into account. And indeed when you find out what they are, you can see that certain features of the design of his experiment are designed to take those contingencies into account" (Garfinkel 2002, 264, note 2; emphasis added).

[12] For a reedition of Sudnow's 1983 *Pilgrim*, see Sudnow's 2020 *Breakout*.

[13] In *Ethnomethodology's Program*, Garfinkel (2002) characterized its studies' "results," empirical and pedagogical, as "tutorial problems" (p. 145) – that is, as problems which disclose "members' discipline-specific procedures," on the one hand, and lend themselves to be discussed with practitioners (*aka* "members") "tell[ing] me [the analyst] what I'm talking about" (ibid.), on the other.

[14] Technically, the "optimal strategy […] to dig a tunnel around the sides" (shots 17-18) may constitute a further case of "specification gaming" (Krakovna et al. 2020), insofar as that *Breakout* strategy allows a player to maximize the score, yet without finishing the game. For further discussion of this "flipside of AI ingenuity," see Krakovna et al. (2020) and Bruder (2020:78-81). I shall return to this argument in the conclusion.

[15] This suggestion, again, was made without showing how the *Breakout* program reaches its overall goal to "eliminate the entire barricade" (Sudnow 1983, 35), assuming that it is able to reach that overall goal. Nota bene: the reenactment-based reanalysis bears on how the *video demonstration* disables "critical evaluation" (Lampel 2021, 305), not on the evidence and analysis by the supporting paper in computer science (Mnih et al. 2015).

[16] To have this lack of diversity disappear seems important from a producer's standpoint, if only to pitch the video demonstration to a broader audience, the intended audience of *AlphaGo. The Movie* (Krieg and Kohs 2017).

[17] The qualifier "conspicuously" alludes to how the "ordinary circumstances" told and shown (e.g., the male child prodigy turned *DeepMind* CEO arriving at Oxford) manifestly omit how the *Breakout* program was set up to achieve its demonstrated performance (i.e., culminating in discovering "this amazing thing […] the optimal strategy," shots 17-18). Its material "set-up" includes various training rounds in "reinforcement learning" and many other technical details (see Mnih et al. 2015). "Specification gaming," from that perspective, may not be a problem, but the aim (see, again, Krakovna et al. 2020).

[18] If early AI envisaged to "reduce epistemology to code" (Penn 2020, 199), then the examined demonstration offered a recurring version of that project, namely to "reduce play to performance" (see Section 3).

[19] To the "child prodigy" (1) and "general AI" (2) configuration, we may add that of the "obscure(d) backstage" (3), insofar as the video demonstration appeared to mobilize the former (1) to account for the latter (2), instead of dwelling on its technical explanation (see Mnih et al. 2015) or self-critical qualification (Krakovna et al. 2020).

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Appendix I

Transcript of "Breakout" Demo – *AlphaGo. The Movie* (Krieg & Kohs 2017, 1:24 – 3:05)

Movie available at: https://www.youtube.com/watch?v=WXuK6gekU1Y (accessed 1 November 2022)
(Transcript prepared by the author in accordance with conventions below)

```
DH*   Demis Hassabis
      (the asterisk marks his categorial identification in the video,
       as "Co-Founder & CEO, DeepMind")
WP    Welcome person
```

Shot	*Voice*	*Audio*	*Video*
1 (1:24)	 (DH*) (DH*)	♬… ((young man shown in taxi..)) …♬… ((.. identified as Demis Hassabis, Co-Founder & CEO, DeepMind)) **when I was a |kid,** |((DH* shown in taxi)) ***#1a*** **I loved, °uh°=>playing games.<** …♬…	 ***#1*** ((DH* shown in taxi))
2	 (DH*) (DH*)	…♬… **I |started off with,** |((DH*, accompanied, is shown to walk in the street, from right to left)) **|board ga:mes, like chess** |*tac, tac, tac* |((DH*'steps in street)) ***#2*** …♬…	 ***#2*** ((DH* shown accompanied, walking towards University of Oxford))
3	 (DH*) (DH*) (DH*)	…♬… **and then I bought my first computer=>when I was eight.<** **with |winnings from a** |*tac, tac, tac* |((DH*'steps in street)) ***#3*** **chess tournament.** |*tac, tac, tac* |((DH*'steps in street)) **ever since then, I felt that, computers were this** …♬… **sort of magical device.** …♬…	 ***#3*** ((DH* shown accompanied, walking towards University of Oxford))

4	(DH*) WP (DH*)	…♬… **that could** **ext'end the** '((turns towards DH*)) ***#4*** **power of your mind.**	 ***#4*** ((DH*, accompanied, approaches university building))
5 (1:48)	(DH*)	…♬… **|"virtual environments** **and games.** …♬… …♬… …♬. |((DH*, accompanied, approaches Oxford univ. building)) ***#5*** **we=**	 ***#5*** ((DH*, accompanied, approaches university building))
6 (1:51)	(DH*)	**=th|ink, they are the** **perfect platform for** |((DH* walks through dark entrance corridor)) ***#6*** **developing and testing** **'AI algorithms.** '((person accompanying DH* enters lecture hall, DH* follows him))	 ***#6*** ((DH* walks through dark entrance corridor))
7 (1:55)	( ) (DH*) (DH*) (DH*)	**(.)** |((top rows of lecture hall are shown…)) **|games. are very** **conve:nient,** **in +tha:t** +((…camera turns to lower floor…)) **a lot of them have** **sco|:res.** |((…showing packed lecture hall and (DH*) as speaker)) ***#7*** **so, it's=**	 ***#7*** ((camera shows packed lecture hall and speaker (DH*)))

8 (1:59)	DH* DH*	**=>very<=ea|:sy,** |((emphasizing gesture)) ***#8*** **to measure incremental progress.(.)**	 ***#8*** ((DH* emphasizes "easy"))
9 (2:01)	 DH*	((camera shot on entire lecture hall)) **so,>I'm gonna show you.<** **a few videos of the** **a:gent sy|stem,** |((emphasizing gesture)) ***#9***	 ***#9*** ((DH*emphasizes "system"))
10 (2:05)	DH*	**the +AI.** +((male public member in top row on the right-hand side is shown to pay close attention)) +((computer music starts)) ♬… ♬… ♬… ***#10*** **so, let's start off with breakout.**	 ***#10*** ((male public member is shown to pay close attention))
11 (2:07)	DH* DH*	**so, here you co|ntrol the** ♬… ♬… ♬… |((hints at "breakout" game shown in presentation)) ***#11*** **bat and ball, and** **you=>are trying to break through this rainbow-colored wall.<**	 ***#11*** ((hints at "breakout" game shown in presentation))
12 (2:12)	DH*	**the +agent system has to** +((close-up shot on "breakout" game)) ♬… ♬… ♬… ***#12*** **learn everything for itself, just from the raw pixels.** ♬… ♬… ♬… **it doesn't know=>what it's controlling.<**	 ***#12*** ((close-up shot on "breakout" game))

13 (2:19)	DH* DH*	**it doesn't** **e|ven kno:w,** |((emphasizing gesture)) ***#13*** **what=** ♬… ♬… ♬… **=>the object of the game<=is.**	 ***#13*** ((emphasizes "it doesn't even know"))
14 (2:22)	DH* DH* ♬… ♬… ♬… DH*	**now (at) the=>beginning<=** **=after a |hundred games.** |((hints at initial "breakout" play)) ***#14*** ♬… ♬… ♬… **you can see the agent is not very good.** ♬… ♬… ♬… **it is=>missing the ball<=most of the time.**	 ***#14*** ((hints at initial "breakout" play))
15 (2:28)	DH* ♬… ♬… ♬… DH* ♬… ♬… ♬… DH* DH* ♬… ♬… ♬…	**but it is starting to get** **the |hang of the idea** |((turns around at "After 300 Games" slide)) ***#15a*** **that the bat(.)** **should go towards the ba|ll. (.)** |((looks into the audience)) ***#15b*** **now after three hundred games, it's about as good as a|ny human** |((looks into the audience)) **can play this.**	 ***#15a*** ((turns around at "After 300 Games" slide))  ***#15b*** ((looks into the audience))
16 (2:37)	DH* DH* ♬… ♬… ♬…	**+and it (pretty much)** +((top-down shot on packed lecture hall and speaker DH*)) ***#16*** **gets the ball back every time.**	 ***#16*** ((top-down shot on packed lecture hall and speaker DH*))

17 (2:41)	DH* DH* DH* DH*	**+(and) we thought=>well,** +((frontal shot on "After 500 Games" slide and speaker DH*)) ***#17a*** ♬… ♬… ♬… **that's pretty<=cool.** **but we left the system playing for another two hundred games.** ♬… ♬… ♬… **and it did this ama+zing thing.** +((frontal shot shows game ball "breaking through")) ***#17b*** ♬… ♬… ♬… **it found the optimal strategy, which=**	 ***#17a*** ((frontal shot on "After 500 Games" slide and speaker DH*))  ***#17b*** ((frontal shot shows game ball "breaking through"))
18 (2:45)	DH* DH* Aud. DH*	**+is to dig a tunnel** +((close-up shot on "breakout" game, with ball bouncing up and down between walls)) +((computer music gets faster)) ♬♬♬… ♬♬♬… ♬♬♬ ***#18*** **around the "si:des.** **"ha,ha,ha.** **and put the ball round the back of the wall.** **the researchers working on this, (they are) amazing AI developers** **so, they are not so good at "breakout" and they=**	 ***#18*** ((close-up shot on "breakout" game, with ball bouncing up and down between walls))
19	DH* DH* DH* DH*	**=didn't know about that strategy.** **so they learned something from their own system,** **which is pretty funny and quite instructive I think** **about the potential for** |((emphasizing gesture)) ***#19*** **general AI.**	 ***#19*** ((DH* emphasizing 'AI potential'))

20	DH*	**So for us what's the next step now?"** ***#20***	 ***#20*** ((shot towards the audience))

Transcription conventions:

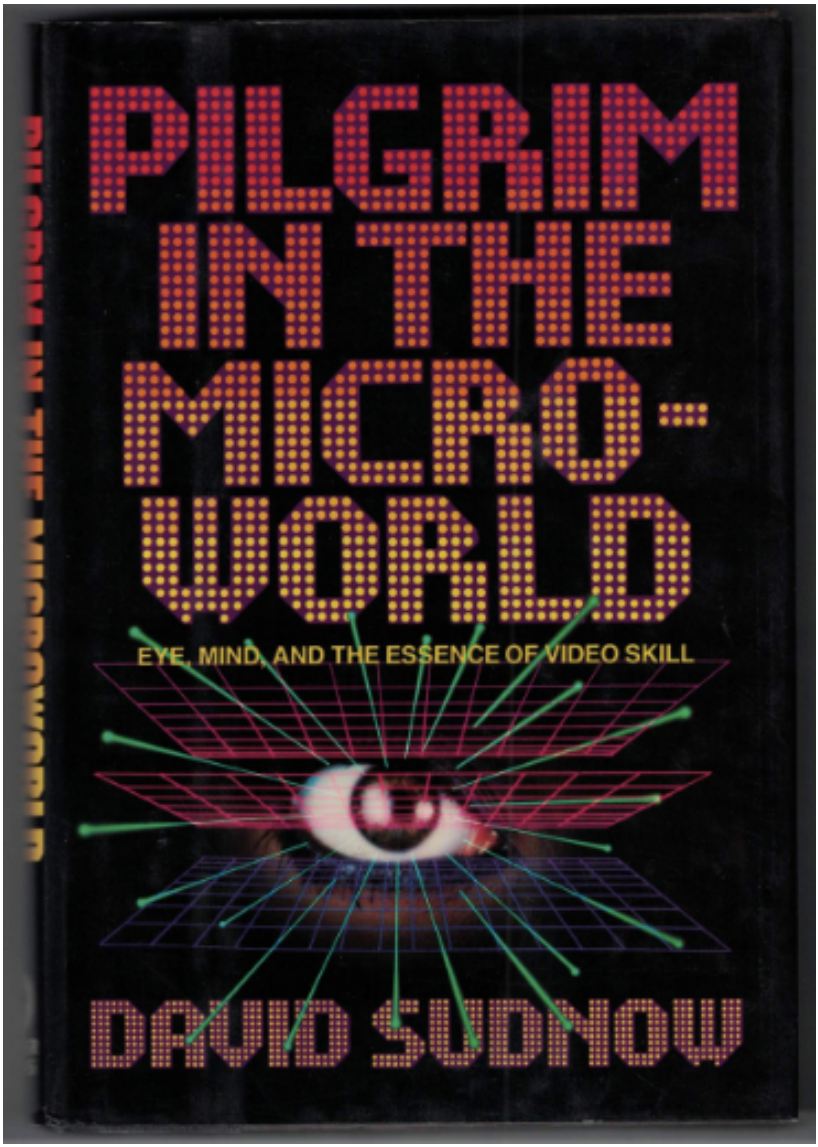
[ ]	onset and end of overlap
=	latching, no discernible interval between adjacent utterances, or activities
(1s)	pause
(.)	micro-pause
he-	cut-off
so	emphasized stretch of talk
>so<	faster stretch of talk
°so°	quieter stretch of talk
?	rising intonation
.	falling intonation
,	"continuing" intonation
" "	start and end of transcribed lecture
()	incomprehensible passage
(go ahead)	uncertain hearing
((does))	description, comment
tac, tac	noise (e.g., steps in the street)

If there is a verbal line, the onset of activity is marked on the verbal line and again on the comment line, as in the following example:

T: **here |I let you have a look.**
|((hands the magnifier to the student))

Film stills / screenshots are numbered (***#1, #2, #3***, etc.) and positioned where taken.

Appendix II: *Pilgrim in the Microworld* Book Cover (1983)



That Obscure Object of Desire: Some Notes for a Slow Art-Science

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Abstract: Although not a book that can be labelled as "art-science", the novel *Atlante Occidentale* (1985), published in English as *Lines of Light*, was conceived by the Italian writer Daniele Del Giudice during a fieldwork visit at the CERN laboratory in Geneva in the early 1980s. The two protagonists, the writer Ira Epstein and the physicist Pietro Brahe, have a common obsession: the drive to experimentation. Both characters seek to create new tools (machines) out of existing material for understanding reality – Pietro a particle collider, Ira the written word. As I argue in the article, *Atlante Occidentale*, a work of fiction, makes a point which should be at the core of any attempt to better understand art-science collaboration: art and science are both ways of world-making.
The article provides readers with a brief overview of the mainstream narratives on and in art-science collaboration and suggests a series of strategies apt for challenging those narratives. First, I argue that experimentation rather than creativity is the glue making any collaboration between art and science possible. Second, I show the importance for both scholars and artists of carrying out laboratory fieldwork and archival research to access science in the making and, hence, to engage in potentially transformative art-science collaborative work. Finally, I call for a radical rethinking of the scale and syntax of art-science projects given that some of the most successful models of such collaborative endeavours are in deep crisis.

Keywords: art-science collaboration; experimentation; fiction; art-science *amateurs*.

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1. Where Art and Science Collide

> All my life, all my work has been nothing more than connecting people to objects, and objects to experience and feelings, to self-perception, to ideas. Perhaps what I have invented so far is nothing more than a special lens, which allows you to see the background and the figure in their relationship, with equal dignity. As a boy you will have been brought up for math, or science. I had an aptitude for people. (Daniele Del Giudice, *Atlante Occidentale* 1985, 62)

The novel *Atlante Occidentale* was conceived by the Italian writer Daniele Del Giudice during a fieldwork visit at the CERN laboratory in Geneva in the early 1980s. First published in 1985 in Italian and then in English as *Lines of Light* (1988), the book has been re-published by the Italian editor Einaudi and enriched by fieldwork notes jotted down by the author. The fieldwork visit took place in the context of the art and science programme *Arts at CERN* that still hosts a series of artist-in-residence projects in the world's largest and most respected centre for scientific research. The first CERN artist-in-residence was the performer James Lee Byars who spent a few Summers at CERN during the 1970s, a stay documented by a few black and white photographs.[1] It is unknown to many, though, that Daniele Del Giudice spent a period at the nuclear research facility in the early 1980s with the purpose of writing a book. The above passage hints at some of the themes and methods that pertain to both art and science: discovery, originality, relational thinking, self-reflexivity, a Gestalt principle of visual perception, the dualism between the qualitative and the quantitative dimension, which is, according to Newfield (2019), how the old dualism between art and science manifests itself.

"Where Art and Science Collide" is the tagline of the Science Gallery international network whose mission is "to ignite creativity and discovery where science and art collide".[2] In the industrialised, economically stronger part of the world, prestigious research institutions, foundations and universities (such as the Wellcome Trust, CERN, the MIT Media Lab, SymbioticA, Laboratoria Art&Science Space, the Science Gallery Network) have been actively supporting art-science programs and initiatives aimed at engaging the lay public with scientific research and science advocacy. The book by Daniele Del Giudice too is about a literal rather than metaphorical collision. The narrative is organised around a chance encounter between an old writer, Ira Epstein, and a young physicist, Pietro Brahe, both amateur pilots. Two cultural matrices, the humanistic and the scientific, avoid a collision (two small aircraft piloted by the two main characters, Pietro Brahe and Ira Epstein, respectively, almost clash in the opening pages of the book). The failed collision is, nevertheless, the engine that kicks off the narrative. Del Giudice's novel was not meant to be about art-science, yet the violent impact avoided at the last second between the two aircraft, an impact that does not literally occur, opens up

the space for a different relationship between the two universes embodied by the protagonists, the world of art (literature included) and that of science. All interactions in the book are anticipated by this first collision, followed by a series of other collisions, such as the one of the underground ring functioning as particle accelerator, and by the imagination of Epstein that creates collisions among words, objects, perception, and action.

Atlante Occidentale is concerned, first and foremost, with language and vision, the two infrastructures that lie beneath art and science. Pietro Brahe monitors streams of protons as they speed around a huge thirty-km ring. His desire is to be able to overcome the limits of his human sensorial apparatus and "see" directly the essence of matter after each experiment, that is the *quid* that the technologies, first, record and then, convey into the form of electronic graphing on the computer screen. In contrast, Ira Epstein has almost given up writing: he cannot write anymore because he "sees" stories – they unfold as pictures in his imagination, unmediated by preconditioning linguistic conventions. Del Giudice's novel attempts to experiment with – if not to combine – a poetic language and the technical precision of a prose devoted to describing an experiment in its unfolding or the breath-taking spectacle of fireworks. As the literature scholar Franco Ricci puts it, through his writing Del Giudice seeks to find a synthesis between the humanistic and the scientific thinking process by asking questions such as:

> What direction will poetic language take when bombarded by scientific specificity? Can such a hybrid language meet the exigencies of the world? (Ricci 1990, 46)

Although not a book that can be labelled as "art-science", *Atlante Occidentale* is an example of a fiction book that should be read by anyone interested in the culture of experimentation across the arts and the sciences. This novel has become a north star during the research, curatorial work and writing I undertook for my own book, *Giving Bodies back to Data*, published in 2021 in the Leonardo art-science series of the MIT Press. The dialogues and encounters between the two protagonists, the young particle physicist Pietro Brahe and the old writer Ira Epstein, showed me how the solid world of magnets, cables, and electronic circuits can suddenly reveal an elusive world of impalpable and invisible phenomena to which artists can give a form.

My present reflections are grounded in extensive work I have conducted both as researcher and as curator of art-science projects. For almost a decade I have been working on the epistemological, aesthetic and historical role played by data-visualisation practices across contemporary biomedicine, neuroscience and the arts (see Casini 2017; 2021a and 2021b). In this article I seek to provide readers, first, with a brief overview of the mainstream narratives on and in art-science collaboration and,

second, with a series of strategies apt for challenging those narratives, using a set of tools coming from the science and technology studies (STS) toolbox and from historical epistemology. I argue that experimentation rather than creativity is the glue making any collaboration between art and science possible. Furthermore, I show the importance of carrying out laboratory fieldwork and archival research to access science in the making and, hence, to engage in potentially transformative art-science collaborative work. Finally, I call for another scale and syntax for art-science projects, given that some of the most successful models of such collaborative endeavours are in deep crisis.

In relation to this last point, one should remember how just a few months ago, the closure of Science Gallery Dublin was announced because the "operational model has run its course".[3] At the time of writing, there is an online public petition for saving SymbioticA, the "artistic laboratory dedicated to the research, learning, critique and hands-on engagement with the life sciences".[4] This space is also under threat of imminent closure by the decision of the University of Western Australia to withdraw its financial support. Although the crisis of such venues might be motivated, on the one hand, by the uncertainties of the present world (such as the global pandemic and the socio-economic consequences of the Russian invasion of Ukraine started early 2022) and, on the other, by the failure of run-as-corporation higher education institutions to provide sustained support for such initiatives, the model of art-science collaboration might need a profound rethinking. Another scale and syntax for art-science projects can emerge from the less structured, tentative, slower-paced approaches to setting up collaborative projects.[5] This type of art-science collaboration would benefit science research communities in a way quite different from the well-established public engagement activities and scientific literacy initiatives that are often wrongly labelled as art-science. My contribution is an invitation to artists and scholars to experiment with ways of better articulating the work of imagination, affectivity and craftsmanship in science practice. By doing so, one would help cultivate a community of science "amateurs" and "connoisseurs" (Stengers 2018) which could be nurtured in the guise of what happens already in the circuits of music and the arts.

2. Experimentation Rather than Creativity to Challenge Dominant Art-Science Narratives

In Del Giudice's novel, Ira Epstein and Pietro Brahe could not differ more. Yet, they have a common obsession: experimentation and the drive to describe the world using different instruments. Pietro tries by exploring subatomic particles inside an underground ring dug under the Jura mountains; Ira is an analytic weaver of stories. Both characters are seeking

to create new tools (machines) out of existing material for understanding reality – Pietro a particle collider, Ira the written word. *Atlante Occidentale* implicitly makes a point which should be at the core of any attempt to better understand art-science collaboration: art and science are both ways of world-making.

The value of experimentation rather than creativity is often undermined by art-science literature and projects that are still framed by certain dominant narratives. The bourgeoning field of Art, Science, and Technology Studies (ASTS) is preceded by seminal research on art and science carried out by researchers in history of science and art, visual culture, image science and STS (Bredekamp, Dünkel and Schneider 2015; Daston and Galison 2010; Elkins 2008; Grau and Veigl 2011; Jones and Galison 1998; Latour and Weibel 2002). As Rogers and Halpern argue in their "Introduction" to the *Routledge Handbook of ASTS* (2021), it is crucial to examine the dominant narratives underpinning our understanding of art-science.

The first narrative is the two-cultures metaphor which:

> became the standard way of talking about the relationship between art and science, even though what constituted these cultures did not remain static. (Rogers and Halpern 2021, 44)

This narrative originates in the Rede lecture (entitled *The Two Cultures*) given in Cambridge by the British scientist and novelist Charles Percy Snow in 1959 and then turned into the well-known book *The Two Cultures and the Scientific Revolution* (1964). Snow lamented the rift between literature and science education and suggested possible means of developing a mutual understanding. The two-culture divide narrative is characterised by the tendency to consider art and science, respectively, as monolithic ahistorical entities, without considering the variety of practices and traditions present in each of them. This narrative is often followed by a call for the arts and humanities to justify their existence by partnering with the sciences.

The second narrative relies on the myth of the lone genius, an idea present both in the context of science and literature but particularly encouraged in the arts. According to this myth, all power, recognition and agency must be given to an individual, with great talent and intellect, without paying much attention to wider socio-technical infrastructures – as well as surrounding economic, epistemic and political conditions – that enable (or not) invention, discoveries and innovative experiments to take place.

Finally, it is worth mentioning the instrumentalism and parasite metaphor which sees science playing the role of the muse for the arts: this narrative becomes dominant also because too often artists' engagement with science is limited to remediating the final products of the scientific laboratory work such as the images and data-visualisation produced during an experiment or by a certain technological apparatus. An example of such use is artists incorporating brain scans in their work without questioning

the status of these image-data. Only a few artists engage with science by using its instruments, the tools, created or used by scientists to produce their outputs. This is a more challenging pathway that requires scientific knowledge, technical skills and infrastructural capacity such as that available in the SymbioticA Laboratory.

To further deepen the understanding of the origin of the art-science rift, one should go to the 1830s, when the term scientist was coined in analogy with the term artist, and the two replaced the early modern "Renaissance Man", whose knowledge was expected to be universal rather than discipline specific (Jones and Galison 1998). The art historian Jean Clair, who curated the exhibition *L'âme au corps: Arts et sciences 1793-1993* (Galeries nationales du Grand Palais, Paris, October 1993-January 1994), laments that the divorce of art and science, which he frames as "spiritual catastrophe", is caused by two circumstances. First, since Romanticism art has given away the monopoly of objectivity to the sciences, keeping for itself only the soft hypertrophy of the ego that characterizes the self-styled genius of the artist. Science, conversely – lost in its graphs and fragmented specialties – has cut itself off from the real world:

> But once the sciences have occupied the various fields of knowledge with their authority, the artist, kicked out from a kingdom he once shared on equal terms and sent back to the empiricism of the craftsman ("stupid as a painter"), the artist cannot help but give himself to soliloquy or prophecy, in search of a status but also of a lost profession. (Clair 2016, 16)[6]

Clair uses the tools offered by art history to demonstrate that this divorce has been only a momentary split. As an example, referring to the drawings of the neurons made by Santiago Ramón y Cajal (1852-1934), regarded as the father of the modern neurosciences, Clair demonstrates how drawing, in particular, has always been in a dialogue with science. With tremendous talent for drawing, Cajal was able to create detailed drawings of the structure of the nervous system observed through the microscope, formulating a theory of the brain as an organ comprising individual nerve cells, the neurons. Rather than simply beautiful visualisations, his drawings provided information (DeFelipe 2010).

Although art-science cross-fertilization is nothing new (Kemp 2005), recent decades have seen an increase in artists challenging the split between the two cultures of science and humanities, creating works that, in some cases, are experiments conducted using the tools, methods, and aesthetics associated with scientific practice.[7] The fact that collaborative projects are increasingly popular softens Clair's pessimism in relation to the possibility of a dialogue between art and science. Nevertheless, his attention to drawing and craftsmanship, that is the belief that art has to do with skill and talent acquired through study and practice, is useful to move away from the Romantic idea of the creative genius. Both the work of Peter Galison (1997) on the traditions of theory, experimentation, and

instrument-building within physics and that carried out by Knorr-Cetina (1999) on the epistemic cultures of molecular biology and high energy physics have already highlighted the existence of different communities within science, thus dismantling a monolithic understanding of science practice. Scholarly work in STS and historical epistemology has explored the connections between the cultures of experimentation in science and art, examining the material practice and the experiential dimension of artists and scientists working in the laboratory and the studio (Patterson 2015; Rheinberger 1997; Schatzi and Knorr-Cetina 2000).

It is, therefore, not creativity that art and science have in common, but the goal of experimenting, of making new worlds by reconfiguring bits and pieces of existing ones. In the words of the philosopher Nelson Goodman, who pointed out how there are no privileged or right ways of describing the world:

> The many stuffs – matter, energy, waves, phenomena – that worlds are made of are made along with the worlds. But made from what? Not from nothing, after all, but from other worlds. (Goodman 1975, 61)

Goodman conceptualises art and science as overlapping segments of a continuum rather than rigidly distinguished on the basis of fictionality (art) versus factuality (science). The laboratory culture of experimentation is like the culture of experimentation present in an artist's studio and in art practice in general. Doing science and making art are both forms of skilled craftsmanship which is part of the intellectual endeavour undertaken in the laboratory and in the artist's studio/workshop (Smith 2004; Jones and Galison 1998). Considering experimentation as the common ground between art and science can foster collaborative projects in which the power relationship between the two is more equally balanced.

The work of biologist and historian of science Hans-Jörg Rheinberger offers a conceptual toolkit to tackle the dominant narratives mentioned. His analysis of experimental systems within science can be extended to art practices and to understanding the relationship between the two systems for producing experiments – albeit of different kinds (Schwab 2013). Rheinberger devotes pages to the analysis of experimentation arguing that the foundational gesture of science is to make things visible in the broader context of laboratory experimentation. An experimental system is set up by two drives, one toward analysis, which is about the examination of the constitutive elements of the phenomenon under study (molecules, chemical elements, physical forces, etc.). The other drive is toward synthesis consists of the effort to create new things (Rheinberger 1997). Although hardly admitted by scientists, what is at stake in experiments, Rheinberger argues, is not hypothesis-testing but an emergent, open-ended, and imaginative interplay between what he calls "epistemic things" (the actual object of inquiry which is still unresolved at the labor-

atory bench) and "technical objects" which are the instruments and techniques used (Rheinberger 1997, 28-29 and 65).

It is this dynamic between epistemic things and technical objects that defines experimentation and makes possible the creation of new worlds. A systematic and multidisciplinary study of this dynamic is the first requirement for framing the relationship between science and art beyond the cliché of creativity as some scholars have convincingly demonstrated in the last few years (Rogers et al. 2021; Borgdorff et al. 2020; Sormani et al. 2019). After all, "experimenting", a term originally closer to the sciences than to the arts, is key for artistic research practice too. Artistic and scientific experiments are different in terms of reproducibility, possibility to generalise results, and controllability (Borgdorff 2013, 115-116). An experiment, regardless of whether it is labelled artistic, scientific or somewhat in-between, always opens up possibilities or, using Rheinberger's own expression, "machines for making the future" (1997, 28), that is, a venue that produces or enables variations, alterations, mismatches, repetitions. The nonalignment between the original intention of the experimenter and the product of artistic or scientific research can be generative of knowledge. An experimental system therefore thrives on uncertainty and surprise.

Among other actions, encouraging experimentation supports and make visible the vast, albeit often unknown, underground world of slow-paced, grassroot and low-budget projects designed and curated by networks of researchers and artists across the globe.[8] These projects draw inspiration from the *Bauhaus Design School* that shaped modernism and levelled any distinction between "artists" and "craftsmen"; they also put to work the possibilities offered by the digital culture and the do-it-with-others spirit, embracing citizen science outside institutional settings. A sustainable, self-reflexive art-science practice is possible by nurturing small-scale bottom-up collaborative projects that give space to actual experimentation rather than just the celebration of creativity and societal impact – typically, the third mission of universities in the Western corporate higher education model.

3. Laboratory Fieldwork and Archival Research as Doors to Fiction, Imagination and Affect within Experimental Culture

In art-science collaboration forms of critique emerge where the outcomes are not obvious from the outset. The collaboration itself is often organised around different and sometimes overlapping logics of interdisciplinarity to use the terminology adopted by Born and Barry (2010): according to the logic of accountability, art-science collaboration can assist scientific research with social accountability by bringing in ethical, political, societal questions. Following the logic of innovation, these collaborations contribute to scientific research thus enabling economic growth. Fi-

nally, according to the logic of ontology, art-science collaboration opens new realms of possibility not seen in everyday laboratory practice, sometimes even producing new objects and knowledge through interdisciplinary research. The last one is the most difficult type of interdisciplinary logic to implement and achieve.

The main roles that the artist or the humanities/social sciences scholar can undertake in the context of laboratory art-science collaboration are that of the attached observer, of the embedded humanist/social scientist/artist, or of the active participant. Sometime these roles can overlap. The role of the "attached observer" (Leach 2006) envisages the scholar/artist embedded in the laboratory as an anthropologist doing ethnographic work, taking down notes of how facts are produced in the everyday laboratory life (Latour and Woolgar 1979). It almost never happens to see a scientist being an "attached observer" in an artist's studio. Another role is that of the "embedded-humanist/social scientist/artist" in the laboratory. The embedded scholar/artist observes and (sporadically) intervenes in scientific practice to shape the course of action of a project/experiment and then they study the product of the intervention (Fisher et al. 2015). The last role can be that of an active participant in a research project in which the humanist/social scientist/artist co-design the project methodology together with the scientist. Active participation can help explore hidden agendas and assumptions at work in the laboratory (Calvert and Schyfter 2016). The output of the collaboration is a co-authored hybrid, which does not necessarily mean that the art and science contribution is equally distributed. Art and design practice, namely, have a "speculative, experimental and open-ended character" (Ingold 2013, 8) that can inform not only scientists, but also researchers in STS conducting collaborative work with scientists (Calvert and Schyfter 2016).

Regardless of the role scholars and/or artists undertake within art-science collaboration illustrated in the previous section, scientific practice should be studied by looking at the "situation" which is defined as:

> the dynamic entanglement of conceptual, material, social, and institutional factors involved in developing knowledge and clearly positions research efforts in relation to the publics for whom such knowledge is expected to be of value. (Leonelli 2016, 8)

Scholars and practitioners involved in art-science collaborative work are in the position of making visible the choices that scientists make in the laboratory. The choices made by scientists with respect to data (their collection, interpretation, and display) emerge from intellectual, technical, political and/or economic struggles, all of which entail power imbalances. These choices remain hidden in the final published output.

This invisibility happens because in scientific practice, "facts", included data-visualisation strategies, are constructed, then stabilised and black-

boxed. In science studies, Bruno Latour defines black boxing as the way scientific, technical and social work is made invisible by its own success. When a machine runs efficiently, when a matter of fact is settled, one needs focus only on its inputs and outputs and not on its internal complexity. Thus, paradoxically, the more science and technology succeed, the opaquer and more obscure they become (Latour 1999, 304). Latour uses the metaphor of the black box to describe scientific practice: to make science is to construct and close a black box. Laboratory findings and events, for example, are often black-boxed and presented as matter of facts. The black box can be re-opened on several occasions. First, when a controversy arises, the solution provided falls apart and there is the need to re-examine the assumptions made. Second, a black box can be opened by looking at the early stages of the development of a technology, for example before the data visualisation protocol becomes standardised. Third, a black box can be opened by artists who enter experimental systems as if they were spaces of imagination.

To focus on the materiality of science, on the epistemological role played by aesthetics, and on the impact that science and technology have on societal and ethical issues, humanities/social sciences scholars and artists engaged in collaborative work with scientists need to pay attention to science in the making. This is visible in the laboratory (science in the making *now*) and in the archive (science in the making *then*). Laboratory ethnography and archival research can provide access to science in the making. The archive and the laboratory bench are places where historical records of science are kept and where scientists make visible their leaps in imagination, their tinkering with materials. Archives are the places where to find what the biologist Francois Jacob calls "night science, the workshop of the possible where what will become the building material of science is worked out" (Jacob 1998, 158). The material coming from archival research and laboratory fieldwork hint at the struggles of scientists with forms of thinking and making that are kept at the margins of the discipline regardless of the central role they play in science. Often hosting unpublished tentative writing and sketches, the archive becomes the repository of "sociotechnical imaginaries" (Jasanoff 2015, 19) rather than of dead documents and objects waiting to be brought back to life. Together with laboratory fieldwork, archival research can help both scholars and artists to bring to the foreground the importance of craftsmanship, imagination and affectivity that always accompany scientific practice and discovery.

Scientific practice is entangled with affect. Science studies using a feminist and new materialist lens, in particular, have long insisted upon the embodied, visceral character of our cognition (Barad 2007; Haraway 1988; Harding 1991). The affective turn has emerged across different disciplines as a mood of inquiry focusing on emotion and affect to generate and re-configure knowledge (Clough and Halley 2007; Massumi 2002; Wilson 2010). Scholars combining STS with anthropology, cognitive

studies and undertaking laboratory fieldwork in different disciplines (from neuroscience to molecular biology and space exploration) have demonstrated how often scientists articulate their science through their bodies. Gestures and imagination contribute to shaping scientific knowledge. Scholars Morana Alač, Natasha Myers and Janet Vertesi all address multimodal embodied practice in the laboratory, basing their works upon extensive laboratory fieldwork in neuroscience, molecular biology and space exploration, respectively. Myers (2015), for example, describes how molecular biologists *feel* their way through data to interpret molecular forms. Vertesi (2014) explores the intimacy that space scientists develop with their instruments through their sensorial apparatus, not only for vision, but also for haptic and remote sensing.

Reflecting on how to access and conceptually frame the role played by affectivity, imagination and fiction within scientific research is important to bring to the foreground experimentation and, thus, challenge all the dominant art-science narratives illustrated in the previous section. The affective register of laboratory labour can emerge both through undertaking laboratory fieldwork and archive-based work. Affectivity is connected to materiality, with reference not just to bodily processes, but also to the material world as a site of affective exchanges between human and non-human agents, including machines and their components. Digging up design sketches, old photographs, lab notes and newspaper clippings that might seem to be marginal at first look (the "cursed" part of scientific research) turns out to be the driving force and narratives behind the development of a certain technology or scientific theory. These "things" are repositories of memory and affective labour. For example, the manual labour involved in the creation of each component of a new technology (from the design and assemblage of hardware to writing the code, to the methods for turning data into images) is not simply a way of taking care of the technological object but much more a way of taking care of the end users of this technology (researchers, prospective patients and further on). Regardless of how collective the labour is, it is always framed around the final publication in which the manual labour mentioned above ends up being significantly neglected. Artists can contribute to digging up the histories of archival objects, of embodied and emotional laboratory work and less institutional narratives related to scientific practice. Foregrounding how affectivity is part of laboratory culture might lead to a scientific practice where matters of concern and care are on equal footing to matters of fact.

Sketches and non-academic writing give access to the dimensions of affectivity, imagination and fiction, often neglected when engaging with the culture of scientific experimentation. Scientists' academic writing that ends up in peer-reviewed papers in prominent journals is polished, authoritative and detached from any context not directly relevant to the data discussed. Modern science is about the production of knowledge: unbiased, factual, objective. A specific writing style corresponds to this new

way of being a scientist: the impersonal style of writing, which is enforced in all academic published outputs, has become the conduit of scientific authority. The published papers in which scientists report the results of their investigations are hardly ever literal accounts of the historical processes through which their authors have reached the conclusions they present. Once an investigation or research project has been completed, the path it followed becomes largely irrelevant to the investigator, who is expected to marshal the best arguments and evidence available to support the claims she wishes to make. Sometimes the case to be presented sufficiently resembles the process of discovery, so that the order of presentation recapitulates the order of investigation; but temporal rearrangements, omissions of failed or aborted trails, and other retrospectively inessential steps, are made routinely, with no intention to falsify a record of discovery. Consequently, scholars aiming to reconstruct the historical and socio-cultural routes to landmark discoveries have long sought other forms of documentation to fill the gaps left by the published reports of the completed work.

Scribblings, notes and sketches belong to the experimental system described by Rheinberger and represent a special genre of scientific writing (Holmes et al. 2003). They are literary activities in their own right. They are the ways in which science is carried out in the multi-dimensional space that exists only on paper – a space where any potential experiment and idea can be given shape, where research threads are laid out even if they might not be easily transposed to the laboratory bench. These writings are precious recordings that can illustrate the specific style (aesthetics) of a scientist's own research and way of thinking. Hardly published in academic papers, these scribblings are confined to personal notebooks, footnotes or appendixes. It is even more important, then, so I argue, to give them a presence back, for example through an art-science collaborative project or through an exhibition.[9]

Experiments undertaken on paper are an explorative fictional tool used to create other worlds. Fiction is at the core of scientific practice (Frigg 2010, 248). According to a common-sense understanding of the term "fiction", something is fictional when it does not exist. Often scientists need to momentarily postulate nonexistent entities because they need them to achieve certain goals or predictions. One well-known example is Bohr's postulation of classical electron orbits, later dismissed by Schrödinger's quantum mechanics. Fiction in the sense of "non-existence" can, therefore, be useful to advance an argument. In a second sense, fiction can be understood as a counterfeit activity with the goal of deceiving or misleading. However, it can also be understood as imagination and make-believe. Scientists use models (as fictional entities) to study features of the object or event that the model is expected to represent. Modeling a phenomenon requires several elements working together so that the audience can engage with and explore the phenomenon in a plausible manner. Philosopher of science Roman Frigg uses the example of fictional characters

in literature (i.e., Madame Bovary and Sherlock Holmes) to argue that scientific models function in a similar way – we believe in them and discuss them although they only live in our imagination (Frigg 2010, 257).

Make-belief (as if), and "what if" constructions are present at the laboratory bench, but they are disciplined in the final academic publications. In public engagement, the play of make-believe – e.g., "what if" scenario-building – is often reduced to an activity only ancillary to science, performed in view of gaining the interest and support of the public for scientific research. Make-believe and imagination are connected to experimentation rather than to creativity. To give an example, the hand-drawn sketches and scribblings by Thomas Edison ("the Wizard of Menlo Park") were visual manipulations of ideas, short-end descriptions and suggestions for the material arrangement of an experiment.[10] Artists are always allowed to play, fictionalize, tinker with materials as part of their experimental process, which is often visible in the final artwork. The same does not apply to scientists. What if constructions are present at the laboratory bench, but they are disciplined and silenced in the final academic publications. Laboratory fieldwork and archival research can reveal how the space of *what if* and make-believe (*as if*) is one of imagination and experimentation, at the same time. The tentative writing and sketches from the laboratory or personal notebooks of scientists show how sometimes scientists draw imaginary objects – that is, they give physical form to their mental images – and in the process of doing so, they learn to see them better. Scientists' laboratory notebook entries and diagrammatic sketches, often accessible either via laboratory fieldwork or archival research, offer an insight into the scientific method and creative process: the passage from intuitive, at times imaginative, understanding to rigorous formal proof and experimentation.

If the contribution of laboratory fieldwork and archival research to access science in the making can be articulated, far more challenging is making explicit what art can bring to science and STS. One could highlight the enhanced self-reflexivity within the laboratory: thanks to collaborative work, scientists become more aware of the cultural, historical, socio-political context in which their practices and instruments are embedded; new forms of interaction with the public, through exhibitions, performances and workshops can be envisaged thanks to collaboration with artists. Humanities scholars and social scientists might be exposed to materiality, process, to the *work* of art (Jones 2022), to methodologies that do not encompass exclusively the written word. Art can not only make visible but also reconfigure and challenge existing modes of experience and sense perception. Time is ripe, then, for adding art to STS. Scholars should be encouraged to embrace multi-sensorial ways of knowing that are at work in the artist's studio but also in scientific practice, moving beyond what Galison identified with *visual* STS (2014). Tactile learning has a role in scientific modelling, for example, in Linus Pauling's molecular

models. Multi-sensory actions are undertaken by the Critical Art Ensemble (CAE), a tactical media collective that combines artistic interventions with performative writing revitalising many STS concepts.

4. Conclusions

To conclude, attention to science (and art) in the making is how social sciences and humanities scholars, artists and scientists can all engage in a fruitful, slow-paced, and mutually challenging dialogues and collaborations. As the historian of science Hans-Jörg Rheinberger has demonstrated, the spaces and practices of experimentation are characterised by uncertainty – where the liveliness of data and experimentation has not yet been stilled by epistemological resolution (Rheinberger 2011, 315). Each experimental system contains narratives in *excess*, both old stories and fragments that might contribute to future stories (Rheinberger 1994, 78). Exploring the affective dimension of science practice and its narratives through laboratory fieldwork and archival research brings out the socio-cultural and political aspects of science in the making. Art-science collaborative work would then become encouraging scientists not only to become aware of the broader history of their practices and tools, but also to reconnect to the imaginative, affective, and craftsmanship dimension of science in the making. When successful, this method can foster the conceptual shift from "matters of fact" to "matters of concern" (Latour 2004) and even to "matters of care" (Puig de la Bellacasa 2017). Matters of fact do not engage with network complexity and power dynamics. Phenomena are observed in a "clinical" way, positioned by the norms created by certain theories and validated throughout certain experimental protocols. Matters of concern reveal the interest and agencies among human and non-human actors. Matters of care, too, engage with the broader, relational contexts that phenomena inhabit as integral parts of the world, but they also actively contribute to make those concerns visible and heard. Thinking with care, namely, is "an active process of intervening in the count of whom and what is ratified as concerned" (Puig de la Bellacasa 2017, 52). This is how worlds can not only be inhabited but also contested and imagined anew.

Notes

[1] https://cds.cern.ch/record/2012228?ln=en (accessed September 2022).

[2] https://www.kcl.ac.uk/news/science-gallery-london-where-art-and-science-collide (accessed October 20, 2022)

[3] Trinity College Provost Linda Doyle on 28th January 2022. See: https://dublin.sciencegallery.com/ (accessed October 21, 2022).

[4] See: https://www.change.org/p/save-symbiotica (accessed October 21, 2022).

[5] An example of such grassroot approaches is discussed in Buiani (2019).

[6] My translation is from the original text in Italian: "Ma una volta che le scienze avranno occupato con autorità i diversi campi del sapere, l'artista, scacciato da un regno che condivideva da pari a pari, rimandato all'empirismo dell'artigiano ('stupido come un pittore'), non potrà far altro che darsi al soliloquio o al vaticinio, alla ricerca di uno status ma anche di un mestiere perduto".

[7] On art-science experiments, see, for example, Webster (2005); Kac (2007); Ginsberg et al. (2014); Sormani et al. (2019).

[8] The journal *Leonardo* is a source of information on both established and more tentative and small-scale projects.

[9] My most recent collaborative project with biomedical physicists and an artist entailed both laboratory fieldwork and archival research. The output consisted of two exhibitions *Immobile Choreography* and *From Where Do We See?* See: http://www.ghat-art.org.uk/immobile-choreography-publication-launch-and-talk/ (accessed November 25, 2019).

[10] See *The Thomas A. Edison Papers Project*, a research centre at Rutgers School of Arts and Sciences, http://edison.rutgers.edu/NamesSearch/SingleDoc.php?DocId=NM003015 (accessed September 15, 2022). On Edison and his visual thinking method, see Wills (2019).

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On Old Age and Its Multiplicity: Exploring Discourses and Materialities about Getting Older

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Abstract: Old age is at the core of complex constellations composed by media discourses, care and mundane activities, and affective and technological practices that involve a wide range of human and non-human actors. While during the last years concepts such as "active" and "successful" ageing have more and more emphasised the individual responsibility of older adults in managing their own health, in the context of the Covid-19 pandemic elderly have been increasingly framed as vulnerable subjects. This Crossing Boundaries will explore the different instances assumed by the "old age" as an emerging object by the enactment of discourses and materialities. In doing so, this Crossing Boundaries mobilizes different theoretical perspectives, such as STS, media studies and sociology of health. The authors will explore three main issues: 1) the public discourse about the health status of older people; 2) the collective management of Alzheimer's disease in and outside institutions; 3) the involvement of older adults in designing information and communication technologies.

Keywords: old age; pandemics, Alzheimer, gerontotechnology; vulnerability.

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Introduction

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To what extent is old age a matter of concern in the contemporary world marked by the Covid-19 Pandemic? This Crossing Boundaries (CB) section of *Tecnoscienza* tries to address this question, gathering three contributions at the crossroads of STS, media studies and sociology of health. Recent research in the field of *age studies*[1] seeks to understand how the old age – and, along with it, the aged bodies and the health conditions of older adults, the self-care practices enacted by them and the expectations that surround this segment of population – is discursively and materially produced in different ways, depending on the time and the spatial context. Across the different historical periods and local settings, new meanings associated with old age can replace or intertwine previous ones, redefining what seems possible, desirable, appropriate, or inappropriate for later life stages. Following the contributions hosted within the Special Issue "Ageing and Technology", previously published for this journal in 2020 (vol 11, no. 2), old age can be interpreted as an object, i.e., "something people act toward and with" (Star 2010, 603) – at the centre of complex constellations of socio-material practices (Cozza et al. 2020). Such constellations are composed by media discourses, care practices and mundane activities, affective and technological practices that involve a wide range of actors (such as older adults, but also peers, relatives, neighbours, new and old media, private companies, innovative or old-fashioned infrastructures and technologies) contributing at configure old age as a matter of concern, that is, an object relevant in a certain temporal and spatial context that, at the same time, materialised in daily relations (see Latour 2004).

Drawing on these theoretical insights, the aim of this CB is to reflect about the different versions of the old age object that emerge from the enactment of some of the above cited discursive and material practices. Considering the so-called "pandemic times" – that have put the elderly and their health conditions at the core of public debate – it is urgent and politically pertinent to reflect (once again) on the practices and meanings associated with the later stages of life. In enacting such a reflection, the authors of this CB will consider the following different settings in which the old age object emerges and takes shape: the public discourse about the health status of older people (see Bosco and Cappellato, this issue); the collective management of Alzheimer's disease in and outside institutions (see Castellaccio, this issue); and the involvement of older adults in designing of information communication technologies (see Piras, this issue). By considering these different settings in which practices and meanings about later stages of life emerge, the three contributions hosted in this CB aim at facing the following questions: 1) What are the different forms that the object

"old age" takes in contemporary society? 2) How do the different forms of old age get in relation to each other? 3) To what extent has Covid-19 affected the stability among these different forms of old age?

The first question regards the *multiplicity* of old age. In this regard, according to Annemarie Mol (2003, 5):

> If practices are foregrounded there is no longer a single passive object in the middle, waiting to be seen from the point of view of seemingly endless series of perspectives. Instead, objects come into being – and disappear – with the practices in which they are manipulated.

Age studies have underlined how since the 80s the role of older people in the contemporary societies has been redefined by the reproduction of complex textures composed by media discourses (Asquith 2009; Shimoni 2018), institutional policies (Lassen and Moreira 2014), technological innovations and daily practices (Lassen 2015; Siira et al. 2020; Carlo and Bonifacio 2021) in which old age is enacted as a period of life compatible with an active role in different everyday domains such as work, health, social engagement and sexuality. This way of conceiving and practicing old age clashes with the pre-existing ones in which older people were represented as passive recipients of pensions (Cumming and Henry 1961), homogeneously characterised by frailty, dependency, loss of cognitive and physical functions (Seefeldt et al. 1977; Midwinter 1991; Ainsworth and Hardy 2007; Martin 2009). Despite the heterogeneous empirical contexts considered by the contributions of this CB, the authors share a common interest toward disentangling the tensions and interactions between the "passive" and the "active" versions of old age: if in the first case older adults are conceived as people needing support (Cozza and De Angeli 2015), in the second one they become directly responsible for their own health and wellbeing.

The second question mentioned above regards the relationships between different forms of old age that emerged over the last few years. As we will see in the next pages, the passive and active versions of old age exist in relation to each other, being characterised by a *mutual constitution relationship*. Paraphrasing Brent Slife (2004, 158):

> the representations and the practices concerning old age – even if they appear absolutely at odds – are not first self-contained entities and then interactive (...), they start out and forever remain in relationship.

A first kind of relationship among the different versions of old age concerns the development of contrasting dichotomies. As argued by various media studies scholars (see Holstein and Minkler 2003; Markson and Taylor 2000; Kessler et al. 2004), the two recurrent versions of old age object – the *old old* (i.e., the elderly with bad health conditions), and the *young old* (i.e., the active and independent older adult) – coexist only in constant conflict with each other. In the media sphere these two versions of old age

are used for reenforcing the idea that the old age can be experienced in two main ways and that – coherently with the neo-liberal ideology that turn bad/poor health in a matter of individual responsibility – the choice among them is up to the individual. Within this CB Bosco and Cappellato, by referring to the Covid-19 pandemic, investigate the juxtaposition between the active ageing/successful ageing rhetoric, the "vulnerability narrative" and the "burden" one. In contrast, Castellaccio and Piras explore collaborative dynamics among the different shape that the object old age can take. In the first contribution, the wide use of digital technologies during the Covid-19 pandemic assured both the assistance to people with Alzheimer's disease and their active involvement in social interactions, useful to treat the symptoms associated with the disease progression. In the second one, in the design processes aimed at developing new gerontechnologies, paternalistic representations of elderly's needs and rhetoric about the importance of their active participation in the enactment of new technologies can coexist. If the rhetoric of older people as active experts is useful for accessing to competitive calls announced by major national and international funding institutions, the image of elderly as passive recipient of care persists both in the projects and their implementation, preserving the interests of research and industrial partners involved in these projects (e.g., developing, evaluating, testing products and services that must have certain characteristics, despite the users' preferences).

The last question addressed by this CB regards the relevance of the Covid-19 pandemic in reshaping and reconfiguring the old age object. As recently observed (Miele and Nunes 2021) the Covid-19 pandemic strengthened mainstream rhetoric that objectified older individuals and favoured the enactment of practices (e.g., selective social isolation and marginalisation) that treat them as fragile recipients of care. Under this perspective, this CB explore in depth the changes and tensions produced by Covid-19 pandemic around old age, defining in detail the public discourses emerged during this global outbreak. In particular, authors focus on the ways through which the discourses emerged during pandemic challenge or reinforce some pre-existent trends in the public sphere, such as the emphasis on their individual responsibility of older adults (see Bosco and Cappellato, this issue) or on the importance given to social relations for their health (see Castellaccio and Piras, this issue).

Overall, this CB provide an understanding of old age object as a collective matter of concern marked by a multiplicity shaped by discourses and materialities enacted by complex networks of actors (Miele and Fornasini 2021). In doing so, this CB open a lively dialogue among different disciplines, as a fruitful way to approach the object old age from different angles and to reach a fully understandings of the ongoing changes that have affected it in the recent times.

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Aging Discourses during the Covid-19 Pandemic

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Through public discourse, concerned groups of people can establish – though not always intentionally or by consensus – what problems should be considered urgent and what issues need to be addressed. During the Covid-19 pandemic, the narratives enacted by different actors (such as policymakers and politicians, academics, "traditional" and digital media) have played a central role in defining how the public views and acknowledges the condition and needs of the older population. This paper explores how public discourses – in their performative dimension – can reveal the collective (partial) capacity to respond to the many issues affecting older adults that emerged during the pandemic emergency.

The Precarious Status of Older Adults

During the first global Covid-19 lockdown, some US economists estimated the cost of reopening at an average of $14.5 million per lost life. For older people, the figure dropped to $9 million, while other estimates valued the lives of people over seventy at only $3.7 million (Feltri 2020). Economic estimates aside, the idea of assigning a lower value to people as they age is not new. Indeed, early theories of aging focused primarily on the deficits associated with it (Bugental and Hehman 2007). Assuming that physical and cognitive decline is inevitable, some scholars described aging as a process of progressive withdrawal or disengagement associated with loss of roles (Cumming and Henry 1961), dependency and frailty (Priestley 2003), and, in some cases, a general deterioration in personal characteristics and emotional state (Makita et al. 2021). This deterioration is often associated with ageism, which the American physician and gerontologist Robert Butler described as early as the 1960s as:

> a deep-seated uneasiness on the part of the young and middle-aged – a personal revulsion to and distaste for growing old, disease and disability; and fear of powerlessness, "uselessness," and death. (Butler 1969, 243)

Over the years, scholars have deepened, broadened, and clarified our understanding of aging processes by adding new concepts and articulations of social and physical characteristics and representations of old age. In addition to explicitly negative attitudes and stereotypes (Cesari and Proietti 2020), hidden and implicit mechanisms have also been identified. One is the so-called compassionate or benevolent ageism, which leads to paternalistic actions and forms of social support that implicitly assign the older population with attributes such as incompetence, frailty, dependency, passivity, and victimhood (Ayalon et al. 2020; Vervaecke and Meisner 2021).

Giving voice to older adults shows that their views of what constitutes wellbeing given the objective or inevitable changes brought by ageing are more varied and positive than younger people tend to believe (Jolanki and Spännäri 2019). Moreover, as reflected in the concept of "gerotranscendence" (Tornstam 1997), aging may be associated with greater emotional stability, life satisfaction, and a more conscious acceptance of human nature despite possible functional limitations under certain conditions. Drawing on physiological, psychological and sociological studies, Rowe and Khan (1997) have introduced the concept of successful aging, suggesting that people can often maintain their cognitive function, good health, and engagement in the community as they age. Over the years, an increasing number of public initiatives have made this prospect more concrete. Since 2002, the World Health Organization (see WHO 2002) has promoted a comprehensive, positive concept of active aging through actions that support older people's health, participation, security and quality of life. In 2012, the European Parliament proclaimed the "Year of Active Aging" and promoted a communication campaign under the slogan "Good health adds life to years" with images of healthy, active older people engaged in working, taking care of children, and even such extreme physical exercise as bungee jumping (see Gibbons 2016). However, both the successful aging paradigm and the active aging paradigm have come under criticism. This is largely due because they have been translated into economically oriented policies that focus on extending working lives without considering the other aspects, such as doing things that make us feel good in stimulating, inclusive, and relational environments (Foster and Walker 2015). Moreover, these perspectives that emphasize individual responsibility risk blaming those who cannot adapt to a rigid model of aging that makes no allowance for the undeniable fact that not all older people are the same (Stephens 2017).

As a result, it seems likely that the value – and not just the economic value – of older people has always had an ambiguous status in different cultures and countries. This has led to narratives that have helped to normalise some representations to the detriment of others. At the same time, older people's

situation in recent decades has been marked by a further intensification of ambivalent dynamics that facilitate the coexistence of contradictory narratives.

According to Becca Levy (2017), the ambiguity is due to processes that, on the one hand, increase the visibility of older adults and their rights, but on the other, make supporting them an extremely demanding burden. Better living conditions have significantly extended the average lifespan. The growing presence of older people in Western societies has been accompanied by an increase in policies and services for them. In addition, increasing efforts to battle diverse discriminations led to the assumption that "age discrimination" against older adults could also be successfully fought. In Levy's view, however, the potential for destigmatising change has been thwarted by several opposing forces: 1) the rapid growth of the anti-aging industry has emphasised the negative aspects of aging in order to boost the silver economy; 2) smaller families and younger adults' geographical mobility have decreased intergenerational contact, leading to loneliness and social exclusion among seniors; 3) due to the lack of specific education aimed at increasing the recognition of the older population's worth, legislations and policies have proven insufficient to change stigmatising beliefs and behaviours; 4) and lastly, the heterogeneity of this segment of the population has slowed the formation of organised groups capable of coordinated action springing from a shared sense of identity (Levy 2017). Technology itself, as well as medical developments, have taken on an ambivalent role, as the extension of life expectancy and the increasing longevity of fragile people increase the cost for the community of their health and social care (Ayalon and Tesch-Römer 2018).

Aging Discourses in the Covid Era

The higher number of deaths among the older population during the Covid-19 pandemic reinforced the assumption that there is a correlation between age and vulnerability, with far-reaching negative consequences (CDC 2021; Alicandro et al. 2022). Assuming that "only certain populations are at risk for infection" creates "an environment in which younger generations may have felt invulnerable to the virus and that health recommendations did not apply to them" (Guest and Peckham 2022, 11). The perception that government measures to contain the virus were necessary to protect older adults intensified intergenerational conflicts (Anderson and Gettings 2022). This fostered resentment and anger toward those blamed for the restrictions that also affected younger people. Lastly, the arbitrary categorisation of older adults based on chronological age boundaries leads to a false homogenisation of the many individual differences and personal diversities seen in later life. The combined effect of these dynamics exacerbated the ambivalent status of older people, for instance by reinforcing ageist stereotypes while reducing attention to the context in which many older people lived (and died) during the long months of the

pandemic (Heymann 2021; Seifert 2021). There were widespread and documented human rights violations against old people in places intended for their protection, such as social and health care facilities and nursing homes (Amnesty International Italia 2020).

During the Covid-19 pandemic, there was a surge of ageist discourses focusing on the need to isolate and distance people over a certain age (Anderson and Gettings 2022). These narratives are linked to an emphasis on the ableism perspective (van der Horst and Vickerstaff 2021), which ascribes value only to a "particular kind of self and body […] that is projected as the perfect, species-typical, and therefore essentially and fully human" (Campbell 2001, 44). Such a view emphasises the otherness of those who do not meet standards, marginalising or nullifying their presence (Chouinard 1997), and promoting the internalisation of self-stigmatisation processes by people with functional limitations (Ayalon and Tesch-Römer 2018). Both European and North American media have "naturalised" a uniform narrative of older people as vulnerable, not self-sufficient and frail, thus reinforcing the intersections between ageism and ableism (Swift and Chasteen 2021; Vervaecke and Meisner 2021). Moreover, ageist practices in hospitals and nursing homes, such as adverse selection in the allocation of scarce resources (i.e., assigning higher priority for access to intensive care to younger people), have long been shrouded from attention (Emanuel et al. 2020).

As a result, the emphasis on individual responsibility for aging that was central to narratives in the pre Covid-19 pandemic period (Miele and Nunes 2022) took on new nuances suggesting mechanisms of blame and paternalism during the global outbreak. Online contents referring to Covid-19 as the "Boomer Remover" which first appeared on Reddit in the US and spread across social media such as Twitter, TikTok, and Instagram, suggested that older people should be sacrificed for younger generations (Meisner 2020; Ehni and Wahl 2020). This is a further instance of intergenerational conflict (Ayalon and Tesch-Römer 2018), with expressions of hostility that legitimised a "process of demographic cleansing of society of over sixty people (Godawa 2021, 92).

Statements by politicians in several countries denoted an explicit negative ageism (Cesari and Proietti 2020), which intentionally justifies prejudiced beliefs by spreading the message that older people are expendable (Barrett et al. 2020). The words of the lieutenant governor of Texas (who called for the self-sacrifice of those over seventy for the economic benefit of America's future generations) or those of the Italian governor of the Liguria region[2] are just a few examples of the widespread anti-aging narrative during the pandemic. Even in the case of benevolent ageism, well-intentioned efforts became harmful by homogenising older adults with phrases such as "our old people" and reinforcing stereotypes related to a supposedly non-self-sufficiency through a paternalistic ethos assuming that older adults need and want help because of their age, even when they do not (Vervaecke and Meisner 2021, 161). Similarly, the "vulnerability narrative"

– which views older people as a homogeneous and undifferentiated group of fragile and vulnerable people who needed to be protected – ties in with the "burden narrative", which focuses on the hardships that young people have had to deal with to protect the older population (Kornadt et al. 2021). Both narratives have been reinforced by the widespread "silver tsunami narrative," which depicts the growing number of old people in Western societies as a problem in terms of sustainability and inflationary healthcare, social, and financial costs (Kingsley 2015).

Conclusions: How Social is Health?

A large multidisciplinary body of research has explored the characteristics and heterogeneity of aging processes, as well as the worrying prevalence of ageist language (Nussbaum et al. 2005) and the unsatisfactory responses to older people's needs in various health and social service settings. Numerous scholars have also emphasised that age itself is not necessarily predictive of Covid-19's clinical outcomes (Ehni and Wahl 2020; Meisner 2020). The etiologic correlation of Covid-19 and advanced age is much weaker when patients' comorbidities are taken into account. The location of outbreaks in terms of settings (e.g., in nursing homes) and geographical areas (especially northern Italy compared with the rest of the country) are also relevant factors for the spread of this disease (Poli 2020, 274). In addition, numerous studies have addressed the "double jeopardy" posed by the combination of ageism with gender- or ethnicity-based stigma (see Bugental and Hehman 2007 for a review about this issue). These studies have critically scrutinised key misconceptions about aging with a wealth of evidence refuting taken-for-granted assumptions. Some scholars argue that aging does not necessarily involve loss and decline, or that under certain conditions we have more control over the aging process than we are led to believe. Moreover, researchers note that many age-related losses may be reversible, as recent studies of brain neuroplasticity confirm. However, if we concentrate our gaze on the years leading up to the pandemic, we can see what Levy (2017) calls the persistent "age stereotype paradox" with a marked increase in prejudice toward older people. Two key discourses on aging continue to emphasise the rising costs to welfare systems' sustainability of extending life spans and reject the collective methods of activation and prevention that call for individual responsibility. This has led to a one-sided, unsatisfactory, and wholly unsubstantiated reading of aging.

Very few of the findings briefly reviewed here have been echoed in public discourses promoted by mainstream media and institutions. Here, it is worth noting that the unsatisfactory status of public debate is not specifically related to discourses on aging. Rather, it reflects the criteria of newsworthiness that emphasise content according to the attention it can receive, without delving into complex social phenomena. Although the pandemic has brought older adults back to the centre of discourses (Miele and Nunes 2022), the latter

have reaffirmed the oversimplification and normalisation of representations and content in new and traditional media (Makita et al. 2021) and in the positions of many institutional and political representatives around the world.

Lastly, aging seems to be the litmus test for what Nancy Fraser in her discussion of the crisis of care (2017) attributes to the social contradictions of contemporary capitalism. On the one hand, as Jolanki and Spännäri (2019) note, the fact that the lack of resources and cuts in social services have meant that welfare systems now seek to cover only what are regarded as basic needs does not allow us to address people's more complex requirements. We thus forget that "human life is much more than meeting the needs defined as basic needs in care contracts" (Jolanki and Spännäri 2019). On the other hand, even if the discourses about our inevitable decline were true, the question arises whether we really want to live in a society that excludes the frail and vulnerable (Dirindin 2018). Moreover, "the 'othering' of 'the elderly'" (Verbruggen et al. 2020, 230) – the claim that older adults are a separate, homogeneous social group – seems unfounded. Older people's condition tells us something about our future and our finitude, which causes us so much anxiety and denial.

Echoing John Rawls' (1971) thoughts on the veil of ignorance, whereby no one knows today what state they may be in tomorrow, "othering" and the idea of inevitable decline can be rejected without resorting to compassionate ageism. Frailty and its implications are not something that concerns only older adults. It concerns society as a whole, and policy makers must decide how to deal with it. The way we care for older people not only affects the people involved, but is one of the most important features of the (more or less) democratic society in which we live.

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Pandemic and Alzheimer's Disease. Have Care Practices for Elderly Patients Been Reconfigured?

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Alzheimer's disease is a condition increasingly common among older people and relevant for understanding broader phenomena (that may also involve other sectors of older populations), such as the reconfiguration of family networks around an especially debilitating disease, the strengths, and the weaknesses of services for non-autonomous elderly and the unmet needs of their caregivers. Considering the impact Alzheimer may have on people, this disease can be considered not only medical, but also "social" for several reasons (Frisone 2002; Pin Le Corre et al. 2009; Ngatcha-Ribert 2012). While there is no doubt that, on a physical-pathological-relational level, it predominantly affects older individuals, this disease also has significant implications for the people who care for them, with roughly 3 million people caring for the sick directly or indirectly. For caregivers and professionals, the social and personal cost is significant since their care work implies immense mental and physical fatigue with episodes of stress, burnout and social withdrawal (Cheng 2017; Moretti and Radin 2019). The onset of Alzheimer's disease acts as a true *biographical disruption* since, almost always, the disease and its management imply a drastic modification of one's life (Bury 1982; Altable and de la Serna 2020). In addition, this disease produces organizational and political-economic consequences on health care systems. As Alzheimer's cases grow, the demand for external and in-home care services increases, with regional networks of public services needing to be strengthened and reorganized. The burden associated with care also represents a point of economic strain, with growing cases calling for further instrumental examinations for diagnostics and monitoring. Beyond material needs, the intense social stigma of Alzheimer's disease persists. According to the World Alzheimer's Report 2019, 35 percent of people have hidden a family member's diagnosis of dementia from at least one person (Alzheimer's Disease International 2019).

The growing biographical, organizational, political, and economic repercussions of Alzheimer's disease for patients, caregivers, and society have been further aggravated by Covid-19 (Cohen et al. 2020). In this respect, it is essential to investigate how care practices for older people with Alzheimer's have changed during the Covid-19 pandemic. Covid-19 has exacerbated the disease, and the psycho-physical and social conditions of caregivers (Cohen et al. 2020), and consequently, caregivers and professionals have reconfigured their care practices, often with the help of digital technologies. This contribution to the CS does not claim to be exhaustive, considering that the Covid-19 pandemic still cannot be said to have ended. Hence, this contribution mainly focuses on patients and caregivers, both inherently inseparable, through a theoretical lens developed at the crossroad between Sociology of Health and Science and Technology Studies.

The Pandemic and Critical Issues for Alzheimer's Patients

During the Covid-19 pandemic in Italy, two lockdowns were particularly relevant regarding restrictions and potential social and economic consequences: the first from March to May 2020 and the second from October 2020 to March 2021, coinciding with the return of winter the following year. These measures were decided on a national scale to reduce the spread of Sars-COV-2, involving social distancing and isolation. The Covid-19 pandemic had enormous social consequences, affecting every sphere and daily activity of the individual (Favretto et al. 2021).

In the context of chronic diseases such as Alzheimer's and other forms of dementia, two scenarios were presented during the pandemic to manage the condition: those who were residing in dedicated facilities[3] and those who instead were at home.

Sick people staying at home in the pre-pandemic period, could take advantage of an array of home care professionals (e.g., geriatrician doctors, nurses, social workers, physiotherapists, and educators) who went to patients and caregiver's homes, and other local support services offered in the area (daycare centers, Alzheimer's Cafes, volunteer work, and Association events).

However, these types of homecare resources were discontinued with the advent of Covid-19. In nursing homes and domestic environments, care practices had to quickly reconfigure to cope with the disintegration of care networks and the rapid worsening of caregivers' social and psychological health resulting from Covid-19 containment measures. Not only did lockdown measures create significant challenges to the practical management of Alzheimer's patients (Caratozzolo et al. 2020), but also to the mental health and well-being of caregivers and professionals who reported cases of chronic stress and burnout (Arcuri et al. 2020; Cravello et al. 2021). Regarding people with Alzheimer's disease, it has been argued that social connection is the best form of treatment for disease progression and, in particular, for preserving the so-called residual abilities (i.e., the cognitive

and physical capabilities not yet affected by the disease): maintaining active relationships, especially with family members, and giving to older persons a role and identity (Kovacs et al. 2021; Cravello et al. 2021). During the pre-Covid-19 pandemic period, those who did not live in residential facilities could access many services: daycare centers; parish-related events; Alzheimer's Cafes; voluntary support groups; city-sponsored events in the area; events and spaces provided by associations; but also, family and friend support; home visits by care aides, educators, nurses, physiotherapists, and geriatricians. Alzheimer's patients, since March 2020, have been largely isolated to reduce virus spread and risk of exposure, resulting in social isolation. This situation has contributed to the sudden progression of the disease as most care and treatment activities have been suspended (Numbers and Brodaty 2020). In general, patients with this type of dementia saw a worsening and deterioration of psychological and physical conditions (El Haj et al. 2020; Lara et al. 2020).

Compounding these stressors, Alzheimer's patients carry a high risk of contracting Covid-19 given the cognitive impairments inherent in the definition of the disease that causes difficulties in following health prevention procedures (such as respecting the physical distancing rules). At the same time, caregivers have also experienced an exacerbation of their condition, coping with several complex issues, such as disrupting the daily routines and increasing caregiving load.

Digitizing Alzheimer's Care: According to a Process of Co-constitution with Digital Technologies

In the context of the Covid-19 pandemic, care practices performed by caregivers in their own home, as well as within healthcare facilities for people with Alzheimer's, have been transformed by the increasing use of information and communication technologies (ICTs). For many families, the digital has entered homes and daily lives in ascendant ways. Using ICTs for daily support has been feasible and, in some cases, useful for contact with the outside world (e.g., using a cell phone or tablet for calls). Since the early 2000s, video calls have been practiced for diagnostic consultations regarding Alzheimer's disease (Loh et al. 2007), putting an early form of telemedicine into practice (Dai et al. 2020). Following the Covid-19 pandemic, telemedicine was readily applied to ensure appropriate support for patients and caregivers: facilitating a virtual network of immediate communication on day-to-day activities between individuals and the care system, thereby activating a "humanized communication" in which the position of the individual was central.

However, technology cannot be reduced to a mere technical tool. As technology is increasingly used in everyday life by older people (including those with medical conditions), the popular image of aging changes: from smartphones, and fitness devices, to electric bicycles and tablets; older adults are seen as capable figures, exercising agency through the use of

technologies (Peine et al. 2017; Peine and Neven 2021). In this regard, the concept of "gerontechnology" has been proposed to define specific technologies for older users, emphasizing how aging inevitably influences (and is influenced by) the design of technology (Kwon 2017). As highlighted in the field of Science and Technology Studies, technologies require to be analyzed within situated settings of interactions, where human subjects and technological objects can cooperate or conflict (Sismondo 2010). Peine and Neven (2021) described such process through the "co-constitution of aging and technology model" (CAT) from the observation that the forms and practices of aging are not given apart from gerontechnologies, but rather aging is constitutive of the technology itself. The CAT model predicts a close and evolving relationship between aging and technology, with both influencing and contaminating each other. Four essential areas cyclically interact with each other: 1) the lives of older people, 2) the imagery of aging, 3) technological artifacts, and 4) their design processes. This process continuously reshapes everyday practices, technologies and the collective imaginary of aging.

The CAT approach may be relevant for understanding the implementation of digital technologies that occurred during the pandemic by Alzheimer's patients, caregivers, and professionals (nurses, healthcare workers, physiotherapists, psychologists, and educators) involved in their daily care. The daily lives of these three actors (patients, caregivers, and care professionals) have changed as a result of being mediated and co-constituted by technologies. From this perspective, aging is seen and understood as a phase of life capable of using ICT. The Covid-19 pandemic has accelerated a process already underway and offered the opportunity for reconfiguring the view of aging concerning the use of digital technologies. As a result, the world for older adults has also changed (despite the fact that the pandemic has cast them into an even more at-risk category). Both technologies and older people shaped each other in many ways: on the one hand, technologies adapted to respond to health emergency needs by using different devices and tools, for example tablets that allowed video calls to maintain a connection with the outside world. On the other hand, older people adapted to technologies to find solutions to meet their needs, requiring them to enhance their expertise, for example for having calls with doctors, professionals, and relatives, but also to perform cognitive exercises.

Technologies stimulated interaction between people with Alzheimer's disease and actors that were required to stay in isolation due to virus containment measures. Smartphones and other digital devices allowed people and patients hosted in healthcare facilities to maintain contact with their relatives and exercise different forms of socialization. Technologies also enable the performance of playful-educational activities for patients. Telemedicine created space for linkages between older people, home patients, and health professionals to create therapeutic alliances. ICT, then, made the provision of online training possible, as well as psychological and legal support services for caregivers. In addition, digital technologies have

changed the everyday life for older adults, and have in-turn been reshaped by them (users). The organizational logic of healthcare facilities and the needs of family members certainly shaped the ways and purposes for which technologies were used. For example, the limited availability of technological infrastructure within nursing homes led to long-distance calls being conducted for limited periods so that all patients and family members had access to this mode of communication.

Finally, the emerging images of Alzheimer's patients have also been reconfigured. The diffusion of ICTs in the everyday life of people with Alzheimer's disease often represented as "living dead" in western societies (Peel 2014), has enhanced the idea that these actors can be in connection with the rest of the world through digital technologies and, at the same time, can become competent and active users of these objects. As technologies are used, new values, practices, and subjectivities are also continuously negotiated (Peine and Neven 2021).

Conclusions

The changes that have emerged during the Covid-19 pandemic concerning the care practices of Alzheimer's patients mainly concern:

1. The increased circulation of digital and ICT, often understood as e-health technologies, that is digital health services, platform, and tool supporting the management of health, illness and wellbeing (Lambousis et al. 2002);
2. An acceleration of co-constitution in the relationship between technology and aging (which had already begun before the pandemic).

Despite the growing implementation of digital technologies, the specific experiences of Alzheimer's patients and their caregivers are still exceptionally precarious and still unfortunately invisible. The precarious reality of caregiving is attributed mainly to the personal and social commitment that disease management requires being overlooked. The caregiver is often not socially recognized or valued, thus constituting a form of unpaid "invisible work" (Star and Strauss 1999), and the pandemic has exacerbated an already fragile situation.

In this framework, the concept of co-constitution between aging and technologies leads to rethinking the relationship between representations of aging, caregiving practices, and digital technologies. In the specific case of Alzheimer's care in the context of the Covid-19 pandemic, this contribution highlighted how digital technologies have changed the lives of patients and their caregivers, setting up a network of relationships that allow for the continuous negotiation by concerned actors of the perception of aging, technology design, elderly life, and digital technologies.

The turning point, also for future studies, lies in considering aging (and related pathologies) appears as a "collective process" that internally involves

media discourses, care and daily living activities, clinical and medical routines, and marketing strategies forming complex constellations (Cozza et al. 2020). According to this view, aging is not only about older adults, but also about other actors (relatives, caregivers, social media, companies, infrastructure, etc.) who, in the process of co-constitution, define what aging is and how the challenges that arise, such as Alzheimer's disease, can be addressed.

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In Need of Seniors in Need: Paternalism, Tensions and Paradoxes in Users' Participation in Gerontechnology Design

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The inclusion of seniors in the design of gerontechnologies is part of a broader discourse that has been developing since the 1970s. Such inclusion affects several domains and promotes the involvement of citizens in the co-production of public services (Osborne et al. 2016), workers in production processes (Bannon et al. 2018) and marginal subjects in rural communities (Chambers 1981), to name a few of the areas of intervention. Despite significant differences, these experiences are united by identifying participation as the key to pursuing the dual goals of encouraging bottom-up democratic processes and proposing technical solutions that are more efficient by increasing the chances of adoption. Although these two objectives are always present, the instrumental view that regards participation as a "good thing" because it enables the creation of better technologies, processes or projects often prevails (Mackay et al. 2000).

The debate is rich, and it questions the very meaning of involvement, which is often presented as a level in scale, given Arnstein's (1969) pioneering work. In such scales, more marginal forms (i.e., consultation) are distinguished to gradually proceed towards more inclusive forms (i.e., involvement, participation) until a role of full and equal collaboration (i.e., co-production) is attributed to prospective users (Stark et al. 2021). In this contribution, similar to much of the relevant literature, I shall use the terms "involvement" and "participation" interchangeably regarding the diverse set of approaches involving different forms of relationships between designers and users[4].

The recent Covid-19 pandemic has made the issue of users' participation in technology design even more relevant, given the growing attention in this period on remote monitoring addressed to older and/or clinically fragile people, with the aim of reducing their access to healthcare facilities and preventing the circulation of virus among these sectors of population. Moreover, the involvement of the elderly in the design of gerontechnologies constitutes a privileged vantage point for analysing some of the diverse social representations of aging. Indeed, in this field, political-institutional drives, epistemic-methodological considerations and pragmatic needs are mixed together and operationalised in policy documents and research practices. Involvement in design processes, when observed from these different perspectives, offers the possibility of highlighting paradoxes and tensions between visions of the elderly, who are at various times considered active subjects, passive receivers of care, subjects in need and individuals needed to realise technologies.

This paper focuses on three representations of the elderly that emerge from their implicit conceptualisation in relation to their contribution to design activities. To present them, I shall build on Robert Cooper

distinction between distal and proximal thinking (1992), the former referring to a structured view of the social in terms of codified interactions and functions and the latter to the continuous network of actions that shapes a set of heterogenous materials. The first representation, the elderly as active expert, presents a distal, high-level and formalised institutional perspective. The other representations, the elderly as diminished user and legitimizer of the design process, emerge from confronting the mundane and pragmatic demands of design practices with users.

Distal Representations of Involvement in Design: The Elderly as Active Experts

From early pioneering experiences, participation has been increasingly codified in institutional processes that often explicitly call for the inclusion of stakeholders in the design, implementation and evaluation processes, with research often becoming a requirement in competitive calls for major national and international funding institutions (Compagna and Kohlbacher 2015), in addition to having a legitimising function (infra, the "legitimising elder").

From a distal perspective, collaboration between designers and the elderly appears to be an opportunity for a positive-sum game, where the adoption of participatory methodologies would enable forms of mutual learning between users and designers, thus contributing to the enrichment of the latter's skills (Björgvinsson et al. 2010; Kushniruk and Nøhr 2016) or transforming their role into that of "facilitators" who would enable users to make the relevant decisions in the process (Sanders and Stapper 2008). This perspective is based on the dual assumption that older people are "experts by experience" (Beimbor et al. 2016) who are capable (if properly guided) of providing guidance to planners while simultaneously taking for granted their interest in active involvement.

From this view, participation in design processes can be considered a specific instance of a general trend. With some level of simplification, the elderly person involved in the development of assistive technology can be likened to a chronic patient who wishes to take charge of their condition by acquiring increasing skills in self-management and making their knowledge gained through personal experience available to peers.

These assumptions, while intercepting and embodying a general "spirit of the times" in the specific realm of the implementation of health and wellness technologies, align with the rhetoric of putting patients "at the centre" or "in the driver's seat" of their own care, which coincides with the notion of gerontechnologies as assistive tools that promote independent living and reduce their need to access to social and health services. Participation is thus welded to a representation of active aging in which individuals are eager to manage their own care and compensate for deficiencies related to the decline of the welfare state (Katz 2000). The elderly people participating in designing technologies of which they may become users are

thus an emblem of "successful aging" that is characterised by an ability to remain productive, active, capable of self-determination and vigorous that comes from staying healthy and managing the risks associated with the passage of age and is presented as a model to be imitated in the neoliberal representation (Latimer 2018; Miele and Nunes 2022). This representation of participants in the design stages transfers to future users of technologies who are discursively configured as individuals interested in self-management of their own health, which aligns with a representation of the expert patient capable of requiring fewer interventions from health services and saving time and costs to the system as a whole (Greenhalgh 2009).

This distal perspective is widely shared in institutional representations and comes in the form of stimulating the adoption of participatory methodologies to the point of prescribing their use (Compagna and Kohlbacher 2015) due to the belief that this constitutes a beneficial situation for all people involved. Elderly patients would exercise their desire to stay active and put their experiences to use, designers would enrich their knowledge and skills, and society would benefit from the implementation of tools that are more closely aligned with the real needs of the target population, with spill-over effects on their condition.

Participation in Collaborative Design Practices: The Elderly as "Diminished" Users

The idea that the elderly population needs digital technologies specifically made for them accompanies the history of the internet and mobile technologies. Underlying this focus is the consideration that the elderly, even the young elderly (55-64 years), as non-natively digital, should be provided with simplified tools that are ergonomically adapted to their limited skills and abilities. The example of a cell phone equipped with large buttons and icons constitutes the best-known manifestation of this trend (Joyce et al. 2007).

This view of the elderly as "diminished users" becomes even more pronounced in the field of assistive technology design, wherein a generic age-related inadequacy is compounded by specific needs related to health conditions, and the elderly are often "implicated but not present in the development" (Frennert and Östlund 2014). Such representations are also reflected in participatory methodologies designed to engage the elderly, which rest on the dual belief that they are characterised by generic age-related deficits and passive receivers of technologies. As noted by Peine et al. (2014), forms of engaging older people in technology design often implicitly assume that this population is unable to actively collaborate in rethinking their living contexts by incorporating new technologies. Instead, the techniques adopted assume the existence of a predetermined set of static needs and demands that the technology should satisfy, and these must be identified by researchers through various techniques. In line with this perspective, critical analyses of gerontechnology implementation

processes have observed how the involvement of seniors is limited to certain stages and not the entire arc, from design to implementation, typically preferring assessment or having seniors' needs represented by their caregivers (Lazar et al. 2016). While from a distal perspective, seniors are considered active subjects, engagement practices are permeated by a "paternalistic stance" (Peine et al. 2014) that infantilises seniors by emphasising their deficits.

Widening our gaze to the debate on approaches to user involvement, the case of gerontechnology development takes some of the tensions highlighted by critical perspectives on participatory approaches to the extreme. Participatory design, for example, considers the encounter between designers and users as the moment at which use is imagined before it happens or "use-before-use" in Redström's (2008) definition. This perspective, which is considered unrealistic by its critics, is countered by several methodological proposals to enable users to take ownership of flexibly made technologies to adapt to unexpected uses. Concepts such as "continuing design-in-use", "continuous design and redesign", "unfinished design" and "meta design" have been proposed to imagine forms of "designing for design after design" (see Ehn 2008). While influential in theoretical debate, such critical perspectives rarely find application in participatory design practices and are virtually absent in the field of gerontechnology development. As a result, the representation of the elderly as a subject characterised by deficits qualifies them as incapable of active participation in processes of appropriation and redesign by relegating them to the role of passive users of tools made to satisfy a stable set of needs.

However, as Peine et al. (2014) observed, the perspective of the elderly person as a "diminished" user cannot be rejected outright, as it allows for the condition to be adequately represented and contributes to the realisation of technologies that offer substantial help for elderly people with severe and well-defined problems. This perspective highlights the tensions between an inclusive view of participation and the existence of difficulties to be overcome in the mundane practices of participatory processes with users with age-related limitations.

Institutionalised Participation: The Legitimising Elder

Since the pioneering experiences of half a century ago, participatory methods have become a prerequisite in various fields, including gerontechnology (Peine and Neven 2019). The institutionalisation of participation as crucial strategy in technology implementation (Compagna and Kohlbacher 2015) finds its concretisation in the policy documents of research-funding institutions. While this constitutes undoubted success for the promoters of participatory methods, it also transforms participation into a required act and a design goal to be achieved with others. In this context, participation in design, regardless of its actual contribution, operates as a legitimation mechanism in which elders involved in design vouch for the appropriateness

of the technical solution in terms of both ease of use and usefulness. In this perspective, elderlies' participation is not perceived as the inclusion of an active expert in the design process (see above) nor it is shaped by the representation of elderlies as diminished users. Rather, participation is requested to fulfil the task of "user involvement" required by funding institutions or expected at societal level.

In the context of competitively funded research, the emergence of paternalism, which is partly inscribed and partly an emerging effect of funding policies, deserves attention. Paternalism is often implicit in funding calls for projects that describe the elderly as subjects "in need" to be supported through dedicated technologies. However, the characteristics of such technologies are often detailed in the call itself and are part of a research and innovation agenda dictated by the research community and the officials of funding institutions. Moreover, the needs of the elderly must be met through the implementation of tools that go "beyond the state of the art". Rather than being at the centre of the process, older people's involvement is confined to moments predetermined by researchers at the funding proposal writing stage and framed in a rigid and barely modifiable timeframe. The combination of this dual mechanism is that any "need" expressed by the elderly must meet the dual requirement of being answered in the technology described in the announcement and particularly in a version of it that requires knowledge advancement (Piras 2021). In this context, it is not surprising that participation is often restricted to the evaluation stages and less present in the actual design stages (Frennert and Östlund 2014), even to the point of indirect forms of involvement, purely for the purpose of legitimising the process (Östlund et al. 2015).

The widespread rhetoric about the centrality of users in design and patients in care processes is supported by implicit assumptions about the desire for participation, which are rarely empirically found. Several papers have shown that involving older people requires significant effort that researchers could not put forth without the support of intermediary organisations (i.e., senior centres, non-profit organisations) (Merkel and Kucharski 2019), whose role in the processes of selection, recruitment and the ability to modify project goals is insufficiently investigated (Piras 2021).

Complexity in recruitment is sometimes related to the representation of the elderly as a condition characterised by a high availability of free time. However, elderly people who are in good condition are often busy with personal or family commitments. Paradoxically, it is these elders who most frequently participate in activities carried out by intermediate organisations. Thus, they become overrepresented in the selection aspect of the design-involvement processes. Conversely, marginal or low-educated individuals become marginalised or uninvolved in favour of older people with more resources, with the design exacerbating social inequalities instead of reducing them (Kühnemund and Hahmann 2016). A limiting case of selection bias is that offered by the SARS-CoV-2 pandemic, in which traditional

in-person collaborative working methods were made impossible. Only a handful of papers testified to engagement processes via digital systems (Cerna et al. 2022; Muñoz et al. 2022), with selection bias favouring elders with sufficient digital literacy and appropriate communication tools who may not be representative of the technology's target population.

Pandemic-related restrictions pose an additional conceptual and practical challenge in imagining methodologies that can combine the pragmatic needs for communication via technology-mediated engagement without excluding segments of the population.

Conclusions

The participatory design processes of gerontechnologies offer a privileged vantage point for analysing aging representations and the tensions and paradoxes among them. The tensions and paradoxes are the product of the gap between idealised forms of participation, which originate from the history and evolution of participatory approaches in technology development and its institutionalisation, as well as the complexity of its implementation.

While the involvement of elderly users is unanimously considered a goal to be pursued, the concrete conditions under which involvement takes place influence not only its forms but also the implicit configurations of users. While the progressive institutionalisation of participation may have consolidated the awareness of the ability of older people to be active partners in every stage of the design process, it risks turning their involvement into "yet another task" and leading to opportunistic approaches.

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Notes

[1] As also done by Peine and Neven (2021), the term Age Studies is used as a label that include a broad strand of studies that have reflected on contemporary representations and practices associated with ageing, using a broad variety of disciplinary backgrounds, including the humanities and the social sciences.

[2] "Yesterday in Liguria, 22 out of 25 deaths were very old patients. Most of them were pensioners who are no longer indispensable to the productive efforts of our country, but who must be protected", see https://tg24.sky.it/politica/2020/11/01/coronavirus-toti-anziani (Accessed May 1, 2022)

[3] It is a socio-sanitary residential facility dedicated to elderly people who are not self-sufficient, who need full-time medical, nursing and rehabilitation assistance and for whom keeping them in their own environment/home is not possible. In Italy it is called RSA (Residenza Sanitaria Assistenziale) which means "health care residence". In the Emilia-Romagna region, it is called CRA (Casa Residenza Anziani) which stands for "home for the elderly".

[4] User-Centered Design refers to those processes in which users contribute to the understanding of the context and needs to be met by designers. Participatory Design refers to active involvement in design, typically through workshops. In co-design, there is a symmetrical relationship between designers and users, who are seen as equal collaborators. Other labels have also been proposed over time and, as mentioned above, are often used interchangeably to refer (generically) to all those design processes that utilise users' involvement in some way.

Borders, Migration, and Technology in the Age of Security: Intervening with STS

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Abstract: In recent years, a broad and multidisciplinary literature has emerged at the intersection of critical border and migration studies, critical security studies, and science and technologies studies (STS). This literature has produced a rich conceptual repertoire for the analysis of digital technologies and infrastructures of border control and mobility governance. This scenario conceptually maps some of the core strands in this debate, which portray borders as complex and multi-located arrangements that create spaces of control and circulation, notions and images of "trusted" and/or "risky" travelers, and a globalized hierarchy of mobility rights. Furthermore, the scenario reflects on some major research avenues for STS to intervene in this debate and expose how border regimes are today imagined, designed, maintained, and critiqued.

Keywords: border studies; migration studies; security studies; border multiple; data infrastructures.

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1. Introduction

Borders have long been subject to theoretical and empirical scrutiny. However, geography and political science scholars, sociologists, anthropologists, or philosophers have been unwilling to provide a satisfying answer to the question: What is a border? Balibar has offered a straightforward reason for this:

> Basically, because we cannot attribute to the border an essence which would be valid in all places and at all times, for all physical scales and time

> periods, and which would be included in the same way in all individual and collective experience. (2002, 75)

The Roman *limes* had little to do with today's sophisticated, militarized, high-tech borders that have emerged primarily in the Global North. Dijstelbloem observes that although the term "expresses delimitation and demarcation, it remains a concept with few limits" (2021, 1). The point is that borders are transforming entities in both their material and symbolic aspects: "[f]or most part of human history, the border was a peripheral thing, [… a] forgotten, far-flung place. Today, it is the center of the political world" (Longo 2017, xii).

This scenario acknowledges – much like the broad spectrum of scholarship at the intersection of critical border and migration studies – the analytical productivity of Balibar's observations that the border today seems to be *overdetermined, polysemic, heterogeneous,* and *ubiquitous* (2002, 97-85). I will not revisit these claims but summarize some dominant conceptual elements that have emerged from the contemporary analyses of (digital) border regimes and their operations and revolve around the idea of the *border multiple* and the *securitization of mobile bodies* – as outlined in the first part of this scenario. The second part reflects on three analytical angles through which STS may intervene here: enactment, infrastructure, imaginaries. This scenario thus aims to provide an orientation to scholars which, in whatever different ways, wish to postulate a more symmetrical understanding of human agency and material structure and explore borders as the socio-material entanglements of people, policies, movements, practices, technologies and artifacts.

2. Unpacking the Border Multiple

Today's borders are dislocated. Border crossing points, such as the airport in Vienna, may have very different appearances but are nonetheless intimately connected with the militarized maritime frontiers of the EU, and the seemingly unbounded, natural sea stands out as a *border zone* conditioned to kill (Heller and Pezzani 2017). Exploring borders as multiple and polymorphous can be a starting point for grasping broader political and social transformations and revealing power dynamics and mechanisms. "Borderings," a term used in plural by Saskia Sassen, "cut across traditional borders and become evident both globally and inside national territory" (2015, 23), revealing the shifts in state sovereignty and territoriality in globalization processes. Likewise, border studies have proposed exploring the heterogeneous sites, at which borders become manifest as institutions of categorization and in- or exclusion as well as in "formal, practical, and popular performances of sovereignty" (Johnson et al. 2011, 66). It has become a common denominator to perceive borders

as *multiplicities* that require a range of concepts to grasp their social, cultural, political, symbolic, and material facets and functions (Paasi 1998; Rumford 2006; Walters 2006). Rumford suggests "seeing like a border" by embarking on a multiperspectival study that takes into account "those at, on, or shaping the border" and calls for acknowledging "the constitutive nature of borders in social and political life" (2012, 897). In other words, the border can be something like an *epistemic prism* for analyzing power transformations and dynamics:

> It is above all a question of politics, about the kinds of social worlds and subjectivities produced at the border and the ways that thought and knowledge can intervene in these processes of production. (Mezzadra and Neilson 2013, 17)

2.1 The Biopolitical Turn

The specific character of borders and their modes of governance in the world have fundamentally changed over time. The multidisciplinary field of border studies grew rapidly in the early nineties after the demise of one of the most notorious border architectures in history – the iron curtain. It found its agenda in, and against, popularized ideas such as a *borderless world* and *deterritorialization*. The *Ashgate Research Companion to Border Studies* introduces the field by noting that after the fall of the Berlin Wall, "[i]n summary, borders are still ubiquitous, are manifested in diverse ways, and have various functions and roles" (Wastl-Walter 2011, 2). A variety of terms – *borderscapes*, *borderlands*, and *border regimes* – have sought to grasp the diverse and various manifestations, shifts, and roles of borders. As Hess and Kasparek argue, border studies:

> emphasize the transformation of the border from a demarcation line surrounding national territory to an ubiquitous, techno-social, deterritorialised apparatus or regime producing geographical stretched borderscapes. (2017, 57)

Such notions challenge the linear and fixed imaginations of borders, instead turning our attention to their multi-location. The idea of borderlands, for instance, points to the phenomena of whole countries or regions becoming zones of transition and no longer having territorial fixity (Balibar 2009; Rumford 2006; Squire 2011). Even more widely in use is the concept of borderscapes, which has been mobilized as an epistemic viewpoint for exploring the border's distinct spatial, temporal, and political dimensions to uncover the hidden geographies and distributions of categories of belonging (Dell'Agnese and Szary 2015; Rajaram and Grundy-Warr 2007). Borders, as Longo aptly notes, "cannot merely be 'tall,' they must also be 'wide' and 'layered'" (2017, 56).

A key component in summarizing some of these transformations of borders is the *biopolitical turn*. It articulates the "multiplicity and multiplication of biopolitical technologies" for the management of mobility and migration (Aradau and Tazzioli 2020, 201). The biopolitical term invokes, perhaps most clearly, the shift in the state's primary concern with *territory* to that of *population*. Foucault (2009) depicted this shift initially by developing his concept of security, tracing biopolitics as a form of governance back to the development of towns in the eighteenth century when the problem of regulating and surveilling populations was first encountered. The objective of governance changed from being concerned with territorial domination to the challenge of managing the influx and circulation of populations: governance became a matter of:

> organizing circulation, eliminating its dangerous elements, making a division between good and bad circulation, and maximizing the good circulation by diminishing the bad. (2009, 18)

Employed to analyze the institution of the border, these insights help to scrutinize the distinct techniques and mechanisms of borders, which aim to include and exclude an "indefinite series of mobile elements" that originate *outside* the field of surveillance: "carts, travelers, thieves, disease, tourists, migrants, criminals" (Feldman 2011, 381). While still predominantly focused on the Global North, the literature's verdict is that the principle of *biopolitics* seems to have supplemented (but not replaced) the principle of *geopolitics*: borders have operated through spatially dispersed and temporally varied tactics of control, semantics, policies, laws, and technical architectures (see Olwig et al. 2019; Schwertl 2018; van Baar 2017; Tazzioli 2020). Consequentially, Walters (2002) conceived the notion of the *biopolitical border* and acknowledged what he calls a process of biopoliticization:

> the political concerns, events, and means by which the border will become a privileged instrument in the systematic regulation of national and transnational populations – their movement, health, and security. (2002, 571)

2.2 Digital Transformations

Unsurprisingly, it has been suggested that the rise of large-scale IT systems and digital technologies has enabled, facilitated, or intensified this biopolitical turn. Borders, as Dijstelbloem observes,

> have a particular relationship with technology. […] Technologies inform – and limit – how societies are governed and can be imagined to be governed. (2021, 9)

The interdisciplinary scholarship has gone to great lengths to unpack the distinct actors, discourses, facets, and functions that carry out today's digitally mediated border controls. Databases intensify what Bonditti (2004) calls the *traceability*. The growing production, collection, and storage of data seek to capture and trace the movement and trajectories of populations, enabling a new form of *digital hyper-documentation* by which "each piece of data is linked to other data, and ultimately to a risk profile" (Salter 2006a, 47). Longo likewise observes a "renewed commitment to us[ing] and deploy[ing] technology at the border" (2017, 56) and ties the emergence and proliferation of databases targeting mobility closely to the performance of biopower. The governmental desire for traceability is thus particularly articulated by the new means of biometric identification, the digitization of asylum and visa procedures, the creation of traveler watch lists or blacklists, and other related mechanisms that track mobilities. Such practices of digital bordering illustrate the shift away from the territorial model of the sovereign border to an increasingly supranational character of mobility control.

The increase in the literature on border and migration control through digital means is also responsible for the proliferation of terms that seem to describe similar, but not identical, phenomena. Scholars have described *digital borders* (e.g., Broeders 2007; Trauttmansdorff 2017; Glouftsios 2019), *technological borders* (Dijstelbloem and Meijer 2011), and *socio-digital borders* (König 2016). Another influential term is Amoore's *biometric border* (Amoore 2006; Muller 2011), defined as the:

> portable border par excellence, carried by mobile bodies […] as it is deployed to divide bodies at international boundaries, airports, railway stations, on subways or city streets, in the office or the neighbourhood. (Amoore 2006, 338)

Amoore underscored the diffuse character of biometric control in the contemporary regimes of mobility management, in which facial images, iris scans, and fingerprints seek to establish the migrant's *embodied identity* (van der Ploeg 2000). In less specific ways, the notions of *mobile borders* (Szary and Giraut 2015) and Côté-Boucher's (2008) *diffuse border* also imply delocalized and spatially diffused characteristics of borders and their biometric reinforcement. Scholars have deployed the idea of the "virtual border" (Zureik and Salter 2006) or the related concept of "bioinformatic border security" (Vukov and Sheller 2013) that mark the shift in borders away from physical or territorial boundaries. Pötzsch's (2015) idea of *iBorder* likewise seeks to signal the exercise of informational power that digital technologies seemingly enable, as does Rygiel's (2011) politics of *e-borders*. Finally, we add the term *liquid borders* (Moraña 2021) to this growing list of signifiers, which, importantly, also acknowledges the

element of *porousness* that haunts every border, no matter how technologized and secured it appears.

It is important to note that these labels are not merely academic concepts; some have also been actively introduced or used by politicians, officials, or industrial actors who strongly promote the development of digital bordering practices. In this regard, the *smart border* stands out as a term that has shaped the discourse and practice of border and migration management policy. Smart borders have thus come under special academic scrutiny (Amoore, Marmura and Salter 2008; Leese 2016; Sontowski 2018; Sparke 2006). This euphemistic and homonymous terminology should not be seen as an accidental outcome but one that has strategically served industry actors, officials, and experts in fostering and legitimizing the underlying visions and meanings of (digital) border security. It does not necessarily mean to refute these notions or to offer a new term. Instead, we should be cautious of some of the unintended effects of many of these notions, i.e., the artificial dichotomy that is invoked between the digital and the physical, the seamless virtual and the robust material. Such dichotomies prevent us from examining the distinct ways and forms in which technologies, devices, artifacts, and the so-called virtual spaces are continuously shaped by social, cultural, economic, and political worlds and always enacted through actors, discourse, and materials. As Ruppert, Law, and Savage note, social scientists should account for the ways in which "digital devices themselves are materially implicated in the production and performance of contemporary sociality" (2013, 22). As much as the biopolitical turn shifts the analytical gaze away from the border as a demarcating line, it becomes necessary to be attuned to the multiple enactments of borders and border security which may take place prior to or after their deployment at the state's territorial boundary (Bourne, Johnson and Lisle 2015; Martin-Mazé and Perret 2021) – i.e., the spaces in which digital borders become not only imagined, designed, and assembled but also monitored, maintained, and repaired. This viewpoint proposes exploring border control and security through deliberate ethnographic fieldwork that can investigate the stickiness of lasting imaginations and narratives as well as the material practices of creating and maintaining borders. As a large body of work has devoted itself to the biopolitical character, its functions, and mechanisms of digitally mediated borders, contributions have thus started to analyze both the imaginative and infrastructural work that is carried out to design and enact digital borders.

3. Digital Border Surveillance and the Securitization of the Mobile Body

3.1 Securitization and Externalization

In the tradition of critical security studies, technologies and databases have been prominently described as being part of the intensifying process of securitizing migration – an umbrella concept that traces, in manifold ways, how mobility and immigration have come to be constructed as a problem of security, especially in the aftermath of the 9/11 terror attacks (Bigo 2002; Amoore 2006; Bello 2022; Huysmans 2000; van Munster 2009). Broadly, (digital) technology is explained here as a core driver in creating the conditions for mass surveillance and perpetuating the logic of risk in contemporary capitalist societies. It has tied border protection and migration management permanently to the question of global (in)security: security professionals, politicians, and bureaucrats envision their security policies and strategies on a global scale while embedding them deeply within the fabric of their national societies (Popescu 2011, 92). The multiplication of borders – away from the physical border, beyond and within territorial boundaries – strongly relates to checks, surveillance, and controls that occur *prior* to the traveler's arrival. This is often referred to as the *externalization* of border security, which has been extensively discussed in the face of the European Union's externalization strategies (e.g., Guiraudon and Lahav 2000; Lavenex 2006; Zaiotti 2016). Externalization is closely associated with what Zolberg once called *remote control* – the "projection of the country of destination's borders into the world at large" (2006, 223-24). For instance, analyses have examined what EU states euphemistically call the "forward-looking" visa policies which have fundamentally transformed the visa regime into a transnational model of governance through information networks (Salter 2006b; Salter and Mutlu 2013). The digitization of bordering practices has considerably refined this work of remote control (through the storage and processing of data doubles) and sought to restrict movement at a distance, subjecting mobile individuals to enrolment procedures long before they embark on their journey. Broeders and Hampshire summarize this claiming "[t]he governance of border traffic in the digital age is evolving into a multi-sited system of remote control" (2013, 1207).

Most of these contributions confirm a more general observation – namely, that border control faces the fundamental problem of guaranteeing security and enforcing control, on the one hand, and facilitating mobility and global flows on the other. This paradox articulates the general contradiction between securitization and (neo)liberal globalization (Amoore 2006), or what Popescu calls "globalization's security dilemma" (2011, 100). But scholars tend to ignore the fact that officials, policymakers, or bureaucrats can be perfectly aware of these issues. They inform

the imaginative and narrative repertoires that justify the investments in deploying digital borders and thereby reproducing technological solutionism – the belief that border security is a problem or dilemma that may be reconciled through digital technologies and growing databases. The category of the *mobile body* is an essential part of this solution – it must be captured and identified to assess its potential risk, ideally before it reaches the border, and it must be sorted accordingly so as not to disrupt the flow of legitimate traffic (Follis 2017; Suchman, Follis and Weber 2017). Contemporary processes of securitization and surveillance at the border have thus sought to proliferate and diversify *traveler categories*, which are granted different rights and ease of mobility and border crossing. The way in which we experience movement today follows the principle of what Adey (2006) aptly summarizes as *divided we move*.

3.2 Mobile Bodies: Identification, Translation, Informatization

Border (in)security has also been explored through the lens of the (surveillant) assemblage (see Allen and Vollmer 2018; Dijstelbloem and Broeders 2015; Sohn 2016; Tsianos and Kuster 2016) – described as the way in which societies are governed through the production of data doubles, which circulate through different centers of calculation with increasing speed and across networked space. In the context of EU databases, Kuster and Tsianos (2016) provide an exemplary approach in their study on the Eurodac system, mobilizing Latour's idea of *immutable mobiles* to show how migrants are forced to register their fingerprints to produce data doubles that are both immutable and hypermobile across virtual networks. In their own words, it is an attempt "to liquefy and freeze mutable, alterable, fluctuating, and varying corporealities" (2016, 59). The *human body* is especially highlighted in the conceptualization of digital bordering in terms of surveillant assemblages: the body is perceived as the primary object of biopoliticization. Popescu has noted that it is, in fact, the body itself that makes an "ideal border": "always at hand, ready to be performed whenever circumstances require" (2011, 103). Likewise, Amoore's notion of the biometric border centers on the body as the locus of the modern state's exercise of biopower: "the body itself is inscribed with, and demarcates, a continual crossing of multiple encoded borders – social, legal, gendered, racialized and so on" (2006, 337). Less evident and often neglected in this scholarship are the very complex and far-from-evident processes, policies, and practices through which the border can become inscribed onto the body. If the multi-located realm of border control is now relocated in the mobile bodies of travelers, what exactly are the arduous and costly forms of labor and resources that are required by a vast array of actors and institutions? Additionally, we find less contributions that study how these ideas, which underpin various policies and governmental strategies, are repeatedly impeded by people on the

move. There are constant frictions, failure, and resistance to the processes of convergence between the body and the border, which characterize the diverse patterns of mobility.

One might take into account, like Annalisa Pelizza (2021), the complex *procedures of translation*. Studying travelers, migrants, or refugees' encounters with borders, as Pelizza argues, requires a translational approach in order to consider the multiple and heterogeneous actors involved in bordering as a performative production of identity. Two related concepts can here discuss the central position of the body-as-border in more complex ways*: informatization of the body* and *embodied identity.* Drawing on the case of the biometric identification, Irma van der Ploeg has argued that biometric identification informatizes the body, i.e., it collects not only information *about* the body but screens the *body-as-information* (van der Ploeg 2000, 2005; Pollozek and Passoth 2019). She claims that the practices of identification do not determine preexisting identities but establish what she calls machine-readable *embodied identity*. This production of illegalized bodies has far-reaching consequences for what we understand as bodily integrity: it radically erases "the space between the person and the identifier" (van der Ploeg 2000, 301). It is the space that defines not only the distribution of power between the state (authorities) and mobile individuals but also the degree to which gendered and racialized bodily differences are enacted and potentially intensified (Kloppenburg and van der Ploeg 2020; M'charek, Schramm, and Skinner 2014). The production of identity at the border, with its inextricable connection to the human body, proves that bodies have become organized and deployed as *evidence* to recognize, categorize, classify, and manage human life itself: bodies are treated as "the origin of evidence and the target of evidence-based interventions" (Maguire, Rao, and Nils 2018, 4; see also Leese, Noori, and Scheel 2022). There is a further need to explore the developments of such regimes of evidence and how they are re-imagined and reperformed in the technopolitics of border regimes – continuing to enter the policies and practices of digital bordering.

4. Advancing STS at the Border

The conceptual strands outlined above portray borders as complex and multi-located arrangements that create spaces of control and circulation, notions and images of "trusted" and "risky" travelers, and a globalized hierarchy of mobility rights. Borders and their infrastructures have become expressions of the increasing (in)securitization and surveillance of mobility, which have targeted and digitized mobile bodies for the purposes of social categorization and sorting. I will now describe three important STS perspectives that build on and expand these insights, primarily by postulating a more symmetrical understanding of human agen-

cy and material structure as well as a situated understanding of migration and border control, which aim to expose the complex socio-material entanglements of people, policies, practices, technologies and artifacts.

4.1 Enacting Migration and (Non-)Knowledge

A perennial concern in STS is the relationship between knowledge and order. Knowledge-making practices – from designing policies and conducting experiments to collecting and visualizing data – are essential for articulating and framing order; knowledge and order reinforce each other's existence (Jasanoff 2004). In line with this principled understanding, Scheel, Ruppert, and Ustek-Spilda (2019) introduced their special issue, "Enacting Migration Through Data Practices," in which they call for studying the onto-politics of data practices – i.e., the performative and political implications of border regimes' data practices that make migration knowable and governable (see also Leese, Noori and Scheel 2022). They postulate that migration must be *enacted*:

> as a single, coherent, measurable reality that can be ordered according to certain policy objectives through data practices. (Scheel, Ruppert and Ustek-Spilda 2019, 585)

The same can be said about surveillance infrastructures – radars, drones, vessels, satellites – as they render visible (or invisible) specific forms and patterns of movement. In particular, scholars emphasize the practices and technologies of *(in)visibilization* that produce knowledge about certain people and their movements, as Tazzioli and Walters argue:

> [M]igration visibility works not only as a means of surveillance and control but more importantly as a way of producing knowledge *on* migration and migrants. (2016, 454)

However, it is also the production of ignorance and nonknowledge – from omission, mistakes, or deliberate deflection – that shape discourses and practices in the governance of mobility (Aradau and Perret 2022; Ustek-Spilda 2020). In other words, knowledge and data do not simply *represent*; "[d]ata enacts that which it represents" (Ruppert, Isin and Bigo 2017, 1), which is a *performative* process that intervenes in the politics of bordering. At the same time, the techniques of data extraction and collection at the border, and the knowledge they produce, are controversial and contested procedures – they are inherently technopolitical (see Pezzani and Heller 2019; Plájás, M'charek and van Baar 2019; van Reekum 2019).

Thus far, most studies have focused how technologies of datafication have been shaped and used by various border constellations, scrutinizing (non)knowledge production at the border. However, knowledge and representation also take place *before* the border. Recent research has been

conducted on the technoscientific/industrial sites in which (future) borders are designed, conceptually emerging from the discussions, visions, and negotiations between various actors such as technicians, engineers, scientists, corporate industry representatives, and security professionals (Baird 2018; Binder 2020; Lemberg-Pedersen 2013; Martin-Mazé and Perret 2021; Schwertl 2018; Valdivia et al. 2022). The new border databases created in the EU, for example, have emerged under conditions that were shaped by funding programs and research and development programs, stakeholder and industry conferences, or in scientific laboratories. Bourne, Johnson, and Lisle provide a meticulous account of how laboratory practices stabilize the (future) border, supported by the promises, norms, and values of a variety of actors, i.e.,

> in the mediations of scientists, end-users, materials, international standards and policies, laboratory practices, immaterial imaginations, and phantasmic figures as they circulate and combine with wider forces of political economy. (2015, 309)

This emphasis on the performative processes of (non)knowledge-making addresses an important critique of the securitization and surveillance literature, which too often have invoked a rather instrumental understanding of technologies in bordering processes. They had often been described as part of a broader rationale (of security or surveillance) that forms a somewhat somber background for political goals and public policy. The performative turn, so to say, allows to see how knowledge-making is instead subjected to the multiple interests and actors in border regimes, as well as the confusion, contestation, failures, and the (un)intended consequences of their design.

4.2 Infrastructuring Borders and Migration

One of the most intriguing STS-informed strands in the border and migration literature conceptually focuses on *infrastructuring*. Anthropologists such as Lin, Lindquist, Xiang, and Yeoh have proposed to analyze migration through the lens of infrastructure, allowing them to:

> [shift] away from the people who move […] towards those human *and* nonhuman actors that move migrants within specific infrastructural frames. (Lin et al. 2017, 169; see also Xiang and Lindquist 2014).

STS scholars likewise mobilize this concept to study how infrastructure mediates and engenders the work that:

> configure[s] actors, elements and their relations, organize[s] access, incorporate[s] political agendas, and treat[s] some issues as irrelevant. (Pollozek and Passoth 2019, 619)

This line of research recommends considering the subtle modes, techniques, or strategies for moving people as *infrastructuring* (i.e., as a verb). The conceptual shift seeks to grasp the manifold and dynamic constellations of the involved actors, practices, artifacts, technologies, but also the narratives through which people become digitized, filed, and processed – in short, it highlights the materiality of migration governance as a meticulous organization of mobility across space and time.

Infrastructures embody the entanglements that connect the digital and the physical; they shape new relationships between authorities and technology, mobility and control, and states and people. Bellanova and Glouftsios, for instance, have illustrated how EU databases "bring together hardware, software and users" and advance what they call "the flickering foundations of the Schengen Area as a controlled space" (2022a, 170). *As infrastructures*, databases serve as powerful enablers of networked control, but they are also highly fragile as their ever-growing capacity for knowledge circulation is constantly undermined by technical failures and breakdowns (Bellanova and de Goede 2022; Glouftsios 2021). Such understandings prevent us from seeing border control as enforcing the ever-present and all-seeing panoptic gaze on mobility. Digital borders are not the durable, robust artifacts and instruments they are often portrayed to be. Instead, the lens of infrastructure renders the border a provisional, incomplete patchwork (Tazzioli and Walters 2016; Dijstelbloem 2017). They require an enormous amount of harmonization and standardization – a constant concern for the actors involved in the governance of migration and part of the painstaking labor that must go into assembling, maintaining, and extending the spaces of security (Leese 2018; Walters 2011).

Infrastructures have thus significantly expanded the repertoire to problematize border and migration control. Their operations require continuous work – from the imagining and symbolically representing epistemic and material orders, to their meticulous design and the maintenance labor that goes into upholding their underlying networks (Lausberg and Pelizza 2021). It directs our attention to a variety of bordering work that is "dependent upon relatively regulated sequences of interpretation and movement" (De Goede 2018, 27; see also van Reekum 2019). Furthermore, infrastructures of border control host multiple encounters between technologies and the movements of people, who subvert, sabotage, escape, or appropriate them. For STS scholars, infrastructuring borders and migration emerges as essential but contingent practices of how mobile populations are inscribed into IT systems or converted into "legible" identities (Pelizza 2020; Van Rossem and Pelizza 2022). These processes become inevitably tied to the construction of the state or transnational institutions (Amelung et al. 2020; Dijstelbloem 2021; Pelizza 2020). The infrastructure's capacity to *process alterity*, in Pelizza's words, emerges as an integral part of institutional orders, underpinning the rationales and practices of categories of belonging and social sorting.

4.3 Imagining Future Borders, Imagining Alternative Futures

Most contributions in this line of research analytically focus on the techno-material aspects of infrastructuring. At times, this comes at the expense of the collective meanings, promises, and visions that any material infrastructure acquires and embodies to exert its power of b/ordering. The distinct imaginative capacities, the ability to craft visions of the future, the mobilization of visionary powers – in short, the collective forms of sociotechnical imagination have often been omitted from existing accounts but are key to understanding the formation of borders and their infrastructures. Borders must be imagined and represented upstream by policy experts, border guards, and other epistemic communities, e.g., at policy gatherings, roundtables, conferences or other spaces where actors meet and engage in the laborious work of envisioning, performing, and justifying digital borders and their solutionist promises. Such spaces enable us to scrutinize also how expertise and expert authority are forged and infused into policymaking processes in the border regime (Martins and Jumbert 2020; Trauttmansdorff 2022). Scholars have thus begun to unearth the collective visions and their relationships with processes of (digital) infrastructuring, i.e., how infrastructures embody specific political visions (Aradau 2010; Leese 2022) or what anxieties and fears inform their design and formatting (Bellanova and Glouftsios 2022b).

STS-informed works may further explore the collectively imagined *futures* that guide individuals and societies in organizing their regimes of border security and migration control. Futures drive social groups and communities toward specific designs and applications of technologies, the definition and production of calculable risks, discourses of fear and threat, protection and exclusion. Industry roundtables, policy meetings, and international security conferences are examples of the powerful tools of political communication and imagination by state authorities. They create the epistemological conditions in which the local and complex realities of migration can be largely ignored, instead focusing on what is framed as techno-scientifically achievable in the future. The future acts here as an "epistemic orientation" and a "moral imperative, a will to anticipate" (Adams, Murphy and Clarke 2009, 254) – directing and shaping knowledges toward speculative forecast and prediction, mobilizing the present as a space of opportunity. Futures are thus seldomly couched only in progressivist terms but routinely invoked with ideas of "crisis" and "emergency." They naturalize and affirm the challenges to social/political order while calling for technological fix. Such framings appear frequently alongside technoscientific futures and, as in the case of the EU, have also repeatedly justified the continuous buildup and implementation of large-scale IT systems for border control (Trauttmansdorff and Felt 2021; Jeandesboz and Pallister-Wilkins 2016; Stierl et al. 2016).

Focusing on the imaginability of future borders thus perceives transformations in border and migration control regimes as always changing and prospective processes. It inevitably reflects on the technopolitical orders of societies and their boundary-making practices. But it also raises the question about alternative futures and alternative migration infrastructures (see Mora-Gámez 2020) that seek to counter the inequalities and violence of contemporary borders. Scholars have repeatedly critiqued some of the prevalent imaginations and justifications of "smart" and "deep" borders (Amoore 2021) – technoscientific visions that propagate the seamless inclusion of travelers in the profitable circuits of mobility but rely on the arbitrary detainment and brutal banishment of human beings. They have also critiqued the political imperative to expand IT systems and the fervent solutionist belief in the unfettered power of data, on which today's mobilities hierarchies and inequalities rest upon. It remains an open task however to reimagine and design futures that not only reject the violent responses to the realities of migration, but also to nurture a politics of responsibility and rights – a politics that involves actors in genuine deliberation about how to create accountability for the injustices and violence that occur at today's borders and works towards a genuine form of mobility justice.

5. Conclusions

The scenario has offered a specific reading of some important conceptual threads in the analyses of (digital) border regimes, departing from the observation about the border multiple. Its aim was to carve out the complementarity of critical border and migration studies and STS but also to suggest some possible analytical vantage points that can be further leveraged, i.e., by investigating how border/migration knowledges are enacted, conceptualizing borders as infrastructure(s), or exploring imaginaries of (future) border and migration control. All these perspectives understand borders as formed in complex and laborious ways; as repeatedly crossed and resisted against; as complex, sociotechnical patchworks of different forms of movements, technologies, desires, and practices. STS-informed studies therefore treat borders as processes of assemblage and translation. Such conceptualizations will always question and transgress what state officials, policymakers, or private companies in border regimes represent as stable, clear-cut, seamless, or fixed entities. STS perspectives can contribute not only to depict borders as fuzzy, fluid, and ambiguous but also challenge what borders must delimit and demarcate as institutionalized within regimes of control and power: the idea of stable referents such as the nation-state, a single geography, a homogenous people, or collective security.

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Anziani, salute e società: Politiche di welfare, discorso pubblico e cura quotidiana [Older people, health and society: Welfare policies, public discourse and daily care] Bologna, il Mulino, 2021, pp. 180

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Demographic ageing is a key driver of social change. Science and Technology Studies (STS) have increasingly turned to ageing as a topic and have done so in trans-disciplinary endeavours at the crossroad of STS and age studies. The theme is not new to Tecnoscienza, which has recently published a special issue on this topic (see Issue 2, 2020). Being one of the guest editors of that special issue, I can say that the response to that call was mainly international, with no contribution coming from Italian researchers working on ageing. There are certainly many possible reasons for this absence that, however, does not help to highlight the state of the art of (Italian) studies on this matter and how age and later life are (or not) matter of concern for policy- and decision-makers in one of the oldest countries in the world (Statista 2021).

Francesco Miele's book is, thus, worthy for two main reasons, among others. First, it contributes an overview of the ageing process in Italy by focusing on – as the subtitle says – three key dimensions: welfare policies, public discourses, and daily care. This choice enables us to appreciate and situate the complexity of the theme. Second, it draws from STS and the Sociology of health as well as from the author's research experience. National and international literature are combined in the analysis of ageing by positioning this book within the landscape of subject-related Italian publications. I wish to further emphasise this second merit as corresponding, in my view, to a necessary effort to legitimise the theme in the Italian scientific environment, especially among the social sciences.

The book is easy to read and clear in articulating its main argument: ageing is a processual "constellation" (p. 10) of policies, discourses, and material practices that co-construct and signify older people's health. It is noteworthy that, throughout the book, Miele makes room for considerations related to how the Covid-19 pandemic has worked as a sort of "stress test" (p. 24) – as he said – magnifying existing criticalities. The reader is accompanied through four chapters that, by examples and conceptual definitions, describe the Italian context.

The first chapter is aimed at presenting the main changes in public policies about Italian older people's health. The description is developed in terms of changes that occurred over time in relation to family networks, care work and its gendered feature, and various services and solutions (long-term care, residential and nursing homes, ageing in place policies,

cash for care). Miele's attention to gender and women's work reveals a sensibility for aspects that are often overlooked in the literature on health and (elderly) care, although – I add – care and careworkers' (mostly women) labour are vital to society in a very material sense. The lack of political and financial support for elderly care in Italy is matched, by Miele, with the neoliberal principles leading contemporary society to prefer "marketization", that is the partial or complete privatization of care services, over any public investments in this sector. This analysis (sadly) aligns Italy to the international context, including the Nordic countries that are often looked at as better equipped when it comes to welfare policies compared to the rest of the European countries (Hansen, Dahl, and Horn 2022). While – based on my reading and research experience both in Italy and Sweden – I am fully convinced by this argument, what disappoints me on a different note is the incipit of this first chapter. Miele frames ageing as a "passage" and associates it with "risk" (p. 15). As long as we – Miele included – agree on defining ageing as a process, we should acknowledge that getting older is not limited to a phase of life but rather progresses since birth: this is what characterises human life. Associating ageing to a specific age (conventionally, 65+), according to a bio-deterministic understanding of it, clashes with the argument of ageing as co-constructed by policies, discourses, and practices. The same argument that matches older people with risks, or higher risks compared to a younger population, is quite controversial. In STS, this issue has been discussed in relation to the concept of "frailty" by stressing that it is important to uncover how science, technology, and medicine have been themselves implicated in the making of the ageing society (Moreira 2017).

Although the beginning of the first chapter may generate disapproval in the readership, especially in critical gerontologists and other (STS) scholars inquiring into this matter, the second chapter comes as a sort of compensation for the previous deterministic introduction of later life as problematic and vulnerable. Indeed, in this chapter, Miele starts by saying that older people have been targeted with many social representations that stereotype them as passive and "in need". In this chapter, as well as in the following two, the author applies STS concepts to elaborate on ageing. In particular, he uses the concept of "biomedicalization" (the complex multisited, multidirectional processes of medicalization extended and reconstituted through emergent social forms and practices of technoscientific biomedicine) and highlights its connection with the molecularization of ageing. According to the "molecular model" (p. 55) an older "patient" can be reduced to their biological components to the point that ageing is meant to be preventable via specific technoscientific interventions. In bringing to the fore this association, Miele highlights an important matter of concern that is related to the above-mentioned marketisation in that, as I discuss elsewhere (Cozza, Ellison and Katz 2022), anti-ageing biohacking is quite a business growing in Europe and in full bloom in US. It is noteworthy that

such interventions, which vary in type, costs, and extremism (from the cosmetic anti-ageing industry to experimental, often unauthorised, biohacking interventions) co-construct the sociotechnical imaginary about ageing and feed ageism – that is, stereotypes, prejudice and discrimination towards others or oneself based on age. This imaginary emerges also in the results of Miele's longitudinal study (January 1985-November 2020) on the *Repubblica* database – the second Italian newspaper regarding circulation – where risk is associated with ageing and biomedical interventions become a moral duty to manage it (age management).

The third chapter is devoted to discussing ageing and health care in relation to older people living at home (in literature called "ageing in place") and affected by multiple chronic diseases. In the author's view, multiple chronic conditions are ideal to study the entwining of formal and informal elderly care work. In particular, Miele mobilises the concepts of "burden of treatment" and "articulation" (p. 85). The former was formulated by May et al. (2014) to understand how people and informal caregivers manage multiple chronic diseases; the latter was used by Corbin and Strauss (1985) to refer to practices and activities to take care of a patient without clashing with other aspects of daily life. By applying these concepts to the results of a qualitative study (2013-2016) conducted in Italy on practices related to ageing in place and multiple chronic diseases, Miele appropriates four daily constructs originally presented in May et al. (2014) to describe caring practices (i.e., sensemaking, monitoring, cognitive participation turned by Miele into "articulation", collective action replaced by "care work"). The overall chapter conveys the complexity of ageing in place with regards to issues such as the availability of a more or less sufficiently active family network, the role of general practitioners subjected to a progressive infra-structural marginalization at the national level, and the constant need for maintenance executed by informal caregivers to keep home elderly services up and running. Surprisingly, what I did not find in this chapter is a wider emphasis on the role of multiple and ubiquitous technologies and various objects and devices that populate older people's homes (Cozza, De Angeli and Tonolli 2017) and multiple chronic conditions all the more.

As in the case of chapter two, which compensates for what I consider a flaw of chapter one, chapter four – compared to chapter three – widely shows the role played by devices in co-defining who/what an older patient is/become. Miele devotes the first part of the chapter to introducing the person-centered care model and comparing it with the standard medical approach regarding dementia care. The choice of focusing on dementia is due to being representative of the main target of long-term care in nursing and residential homes. By drawing on STS, the author shows how dementia is "multiple" (p. 120) and its definition and treatment depend on the institutional context the older person lives in. To substantiate his analysis,

Miele refers to a past ethnography (2019-2020) that he conducted in specific institutional contexts – called *nuclei protetti* in Italian – by paying attention to the daily work of healthcare professionals (in Italian, *operatori socio-sanitari* or OSS). In expanding the (national) narrative about ageing and dementia, Miele highlights also the role of devices such as patients' medical records and affordances of institutional spaces in enacting multiple definitions of dementia and, ultimately, co-constructing situated ideas of personhood. At the end of the chapter, Miele emphasises how caring is not detached from sentiments and emotions, which – I add – are deeply interrelated with the concept of care as affective relations and, even more, with caring as a form of relating.

All in all, this book is worth reading to get an overview of the Italian context and how ageing is part of or overlook by policies and public discourse, and co-shaped by social and material practices at home and in institutional settings. Readers knowledgeable about scholarly contributions on ageing and elderly care may appreciate the continuity between Italian trends sketched in this book and those discussed in the international literature (for example, the marketization of care, the gendering of care, the biomedicalization of age-based interventions).

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Angela Balzano, Elisa Bosisio, Ilaria Santoemma (eds.)
Conchiglie, Pinguini, Staminali: Verso Futuri Transpecie [Shells, Penguins, Stem Cells: Toward Trans-species Futures], Roma, DeriveApprodi, 2022, pp. 288

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Conchiglie, Pinguini, Staminali is a collection of essays, previously published in English, by some of the most influential and creative feminist thinkers (Stacy Alaimo, Melinda Cooper, Beth Dempster, Sarah Franklin, Donna Haraway, Luciana Parisi, María Puig de la Bellacasa, Zoe Sofia, Noël Sturgeon). By translating their works into Italian, this book fills, at least in part, the lack of attention on the feminist ecological perspective within the Italian scholarly and editorial world. As the editors' state in their Introduction *Com/pensare la cura transpecie* [*Thinking(with) trans-species care*], the collection aims to:

> bring in Italian contributions of many scholars and activists who urge us not to untie science and technology studies from the critical perspectives offered by eco/cyborg/transfeminisms. (p. 5, my translation)

The rich introduction is signed by the editors Angela Balzano (author of *Per Farla Finita con la Famiglia*, 2021), Elisa Bosisio and Ilaria Santoemma – three prominent Italian feminist thinkers – and offers a very dense (and sometimes even slightly obstructive for those unfamiliar with a certain language) path within feminist new materialist literature. A clear political intent justifies the choice of each contribution, which overall is meant as a toolbox fundamental to the production of critical thought and practice:

> it is then a matter of *training*, that is, of continuing to *sharpen with passion and dedication* our thinking abilities, always rooted in bodies and matter, to make them better. (p. 30, my translation, italics in the original).

The book is divided into two parts. The first brings together contributions to "thinking technoscience beyond autopoietic reproduction" (p. 5, my translation) by drawing from works of feminist authors who have reflected on the productive system (i.e., the market) as always a (re)productive system. In these essays, the theme of reproduction, in its connection with new biotechnology, is analyzed through a feminist perspective and the link between new anti-feminist fundamentalism in defense of "life", heteronormative reproduction and "*ecocidal*" devastation is central. The second part of the book explores "trans-species futures" to "take care of past and

present" (p. 5, my translation). It presents a series of contributions to imagine alternative futures, aware of the interrelationship between past, present and future. The feminist standpoint of the authors allows them to refuse both techno-optimism and technophobia, both transhumanist enthusiasm and humanist catastrophism. Instead, the editors describe themselves as situated "biohackers" (p. 10), committed to imagining alternative, trans-species and anti-patriarchal forms of kinship and new technonatural-semiotic hybrid assemblages, in full Harawayan style.

Melinda Cooper's first essay, *Stagnazione secolare: La paura di un futuro non-riproduttivo* [original title: *Secular Stagnation: Fear of a non-reproductive future*] reflects on the eternal return of secular stagnation theories that would explain crises of economic stagnation in relation to demographic trends. Cooper points out that at the heart of that theory is an "equation between the nonreproductive logic of finance capital and the nonreproductive (or excessive or insufficient) desire of the surplus population" (p. 61, my translation). The author dwells on it to denounce the return of reproductive nationalism and the obligation to heterosexual reproduction as a tool that conceals the asymmetries of capitalism.

Older than any of the others, but no less relevant, Zoe Sofia's essay *Feti sterminatori* [original title: *Exterminating Fetuses: Abortion, disarmament, and the sexo-semiotics of extraterrestrialism*] (published in 1984) enacts what the author calls a "*sexo-semiotics of technology*" (p. 64, original version). Sofia discusses the debate about abortion and the obsessive and dualistic focus on the fetus by both pro-life and pro-choice parties, which always excludes the situated relation between fetus and women bodies. She reflects on the abstractness of this rhetoric of the unborn also in connection to *2001: A Space Odyssey,* as:

> aspects of an ideological apparatus which addresses extinction fears only to distract us from the exterminating practices of the military-industrial complex. (p. 63, my translation)

Reflections on military technologies and abortion are woven into a broader discourse on technologies (which the author believes as always (re)productive), and on the temporality of capitalist progress as well as on the possibility of opening up spaces of real care for the existing.

L'impatto biotecnologico [original title: *The Bio-technological impact and Abstract Sex*] is a translation of the second and third paragraphs of the first chapter of Luciana Parisi's book *Abstract Sex: Philosophy, Bio-technology, and the Mutations of Desire* (2004). The essay, in dialogue with Donna Haraway's *Cyborg Manifesto* (1991), reflects upon the impact of new bio/info-technologies on sexual reproduction and strongly criticizes any attempt to naturalize bodies and reproduction. New technologies allow us to think about bodies not in relation to their functions but rather to their transformative possibilities. The concept of *abstract sex* places the body in

relation to the Deleuzian and Guattarian concept of the abstract machine, as a layering and continuous variation of biophysical, biocultural, and biodigital elements. As the abstract machine, *Abstract Sex* implies the priority of the virtual on the actual organization of matter (body): the body is always more than its normative biological description and matter has an "unpredictable transformative potential" (p. 91, my translation).

Beth Dempster's essay *I sistemi simpoietici e i sistemi autopietici* [original title: *Sympoietic and autopoietic systems: A new distinction for self-organizing systems*] acts as the glue between the first and second part of the collection. The author discusses the concept of system and, in particular, criticizes Maturana and Varela's autopoietic conception of living systems. Opposed to it is the idea of sympoiesis, which emphasizes the openness of living systems, characterized by dynamic and complex relationality.

Parentele future [*Future Kinship.* Original title*: After IVF*] by Sarah Franklin is again a translation of the eighth chapter of the book *Biological relatives, IVF, Stem Cells and the Future of Kinship* (2013). The author reflects on IVF (In Vitro Fertilization) to think about new forms of kinship. IVF reveals that technological development does not have a linear path only aimed at satisfying predetermined goals but is always a harbinger of hidden possibilities that can change the goals and transform the subjectivities involved. Moreover, according to the author, it undermines the "imaginary biological naturalism" (p. 139, my translation) and shows that biology itself is not fixed but changes through technology that, in turn, becomes more and more biological along the process. Biological reproduction is no longer the only form of reproduction, and this offers unprecedented scenarios for thinking about alternative forms of kinship and parenting.

The sixth chapter, *Fabulazioni speculative per le generazioni della tecnocultura* [original title: *Speculative fabulations for technoculture's generations: Taking care of unexpected country*], is a translation of a paper by Donna Haraway on the works of Patricia Piccinini within the catalog of a 2007 exhibition of hers. Piccinini's works show odd creatures as the result of genetic engineering and cloning. Through them, Haraway reflects on the role of science and technology in the context of the ecological crisis. To the Western technoscience that always destroys the past to replace it with something new (following the mantra of creative destruction), she opposes a technoculture of hybridization that creates new forms of queer care and kinship. Haraway imagines trans-species futures emphasizing the critical role of biotechnology for an ecology aimed not at "restoring" Nature but to unexpected generations.

Valori Familiari fra i Pinguini [original title: *Penguin Family Values: The nature of planetary environmental reproductive justice.* Second chapter of the book *Environmentalism in popular culture: Gender, race, sexuality and the politics of the natural,* 2008*]* by Noël Sturgeon brings together reflec-

tions on sexuality and reproduction and ecological crisis and the Anthropocene. The author shows how penguins have often been taken as a symbol of climate change but also chosen as an emblem of the heterosexual and familist norm by neo-fundamentalists or even as a symbol of gay parenting by the homosexual community. The author criticizes the anthropomorphization underlying these approaches and the use of a naturalized nature as a tool to establish the boundaries of the acceptable and the unacceptable. Overcoming a naturalized, familistic and heteronormative conception of reproduction is identified as a crucial step for the collective survival of humans and non-humans.

Stacy Alaimo reflects on the limits of the Anthropocene concept in the essay *Conchiglie in Acido* [*Shells on Acid.* Original title: *Your Shell on Acid: Material immersion, Anthropocene dissolves.* Sixth chapter of the book *Exposed: Environmental politics and pleasures in posthuman times,* 2016]. The author engages with some important authors, particularly Dipesh Chakrabarty. By discussing some of his limits, she exposes the potential of a neo-materialist and feminist approach to the ecological question, not avoiding confronting some important critiques. With an overturning of gaze, Alaimo invites us to look at the Earth not from outer space but from the depths of the seas: shells, which due to the acidification of the oceans tend to pulverize, become a warning to think about transcorporeality. Alaimo criticizes the idea that the world is "constituted mainly by entities extrinsic to the self, objects intended for human consumption" (p. 238, my translation).

Maria Puig de la Bellacasa's essay, *Pensare con (la) Cura* [original title: *Thinking with Care.* Second chapter of the book *Matters of care: Speculative ethics in more than human worlds,* 2017], concludes the collection. The author takes up some of Donna Haraway's fundamental concepts to reflect on a relational form of thinking practice and on thinking-with as a form of situated care. Thinking-with means finding forms of mutual accountability and transforming thinking into an ethical-political practice that opposes the transcendent ideal of an "objective" knowledge as a gaze from nowhere in favor of a theory of standpoint and situated knowledges.

The book overall is a complex assemblage. The themes of the body/technology, culture/nature relationships are certainly central to all the essays, but each contribution offers a particular perspective and, more importantly, renounces and indeed dismantles the universalistic and abstract claim of an alleged scientific methodology. Instead, a situated (Haraway 1991) and partisan standpoint is privileged by the authors. Moreover, the order in which the essays are arranged is not by chance but rather built to create a second narrative exceeding the content of every single essay. The editors' introduction helps to grasp this unity: (re)production is undoubtedly at the heart of the collection, reproduction being understood here in a broad sense, in relation to non-human critters and the survival of the planet.

The collection finally translates into Italian some sorely missed cornerstones of contemporary feminist thought. These are authors of the highest caliber, and each essay is very dense and thought-provoking. The assemblage work of the editors really succeeds in conveying the ways of an alternative and situated knowledge and a practice of *thinking-with* the authors and beyond. As a whole, as much as in the single essays, the political and ethical urgency animating the book and so well described in the introduction, emerges. The editors' intent to provide conceptual tools in order to *stay with the trouble* (Haraway 2016) is undoubtedly successful, although at times, precisely because of the richness and density of the contributions, one runs the risk of losing the nexus that holds together these different essays. In any case, *Conchiglie, Pinguini, Staminali* is an essential collection for anyone interested in STS from a feminist and ecological perspective.

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Bruno Latour, Émilie Hermant

Paris Ville Invisible [*Paris: Invisible City*], Paris, B42, 2021, pp. 184 [reedition of *Paris Ville Invisible*, Paris, La Découverte, 1998]

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Why is *Paris Ville Invisible* considered one of actor-network theory's (afterwards: ANT) most influential pieces? To answer this question, I will focus on the book's major contribution to ANT's intellectual project while reviewing Éditions B42's newly published edition of Bruno Latour and Émile Hermant's original piece from 1998.

Paris Ville Invisible emerged from an unease that characterises ANT's core premise of avoiding structural explanations of social phenomena. In the 2021 preface, Bruno Latour expresses how he never understood how sociologists were so adept at explaining social phenomena. This is where Émilie Hermant, presented amusingly in the preface as a hobby photographer as well as an eminent researcher, came up with the idea to photograph the emergence of collective concerns. Inspired by Italo Calvino's *Le città invisibili*, both embarked on a journey *inside* Paris to collect, make visible and visualize the city without assuming it as a whole. It was their mission to make Paris visible by keeping it invisible; or, put differently, by showing how impossible it was to make Paris appear as a whole, to be *one*. The new edition and the original piece thus mix photo-essay and textual passages that allow us to explore the city of Paris in myriad ways.

The hybrid organisation of the book follows ANT's experimental writing genre: it contains *séquences* (4), *figures* (13) and *plans* (55). The four *séquences* – *cheminer* (walking), *dimensionner* (scaling), *distributer* (distributing), *permettre* (enabling) – show how the city of Paris can be viewed as things; how social phenomena can be aggregated, calculated, sorted, grouped, related, measured, or quantified according to an assortment of apparatuses that are put together to follow the directions "in sequence". The scene shifts from Mme Baysal's office, where she organizes and allots *École des Mines*' lecture rooms from her desk, making telephone calls, filling in schedules, and filing papers, to *Météo-France*, where one of its employers is talking to the National television about the reports they had sent earlier. These *plans* portray situations in which Paris becomes either a geographical entity, a bureaucratic designation or even a street sign. The *figures* display how these settings are co-articulated, aligned, or circulated in various operational gestures. Following what has been called the "sociology of translation", that is ANT, we have various chains of events in which information is passed on, moulded, fabricated, and ultimately transformed. Hence, there is no difference between a file that has to be classified in a folder by a university assistant, a name tag pinned to a shirt to facilitate

identification or a café bill printed by a machine. All these "translations" are aggregates and need to be analysed on their own since, for instance, the metro report never reflects the weather exactly.

What made me say before this book was influential? Aside from not having been published with an anglophone publisher, the book does not appear as a major reference in Latour's publication list or most of early-ANT's referential articles. Even the oversized French edition from 1998 was out of print for a long time and not reprinted by any publisher. Yet, Latour and Hermant's piece is of particular importance to STS scholars, precisely for those who have taken an interest in the ways (urban) infrastructures are involved in technological and political disputes, in maintenance and care practices, or sensors and algorithms (Denis and Pontille 2014; Tironi and Criado 2015). Accordingly, the multiplicity of compositions of what a city is, as shown by *Paris Ville Invisible* has laid the groundwork and inspired nearly all of the prosaic STS movements that employ the urban as a reassembled research object. This applies to STS scholars who are interested in the coexistence of urban infrastructures, signs, and politics, as well as urban scholars searching for a companionable but unconventional "fellow" in ANT. This is why we might argue that *Paris Ville Invisible* offers as much a peek into modalities of "invisible" action as it does into the emergence of material-semiotic associations that bind all sorts of entities into hybrid collectives.

Apart from launching ANT into disciplinary fields that are concerned with urban phenomena and their related infrastructures or activities, *Paris Ville Invisible* offers a heuristic device for identifying the invisibility of layers of action: the *oligopticon*. Consider a computer displaying a coloured map of Paris on one of those old grey cubes. On it, you can see nothing of Paris but a map showing the city's boundaries and some charts of water flow meters. We have two things here, first, the megalomaniacal confusion between a map and a territory and second, the belief that one "dominates" all of Paris simply by looking at it. An enthralling feature of the book is how bureaucratic procedures or daily encounters with technologies, like scientific protocols or technical reports, or any kind of transaction for that matter, bind objects to a reality. As such, signs on streets and subways carry significance not because they mark locations or indicate directions, but because they articulate the coexistence of "successions" (time) and "simultaneities" (space) (p. 168). Objects such as synoptic maps, models, reports, signs, or bills become entangled in kaleidoscopic practices through which a city can be regulated, calculated, inhabited. The objects offer sometimes mere "panoramic views" that are weakly connected to what they depict, and sometimes these objects are implicated in various prosaic practices that are central to the condition of water regulation, electricity systems, infrastructure maintenance or the performativity of any urban inscription.

One of the core characteristics of ANT is here empirically demonstrated by the way it pays attention to simultaneities, or to put it in more common ANT vocabulary, modes of "coexistence" (p. 169). In addition to the book's analytical intent to examine how action unfolds in irreductive form, the main focus is on how intermediaries turn action into knowledge, and models into action. ANT reveals one of its particular abilities here which places everything on the same plane of existence yet it distinguishes between the various modes through which things exist: from collected data such as time or temperature, to their computation via sensors or computers to the models and maps created by institutions such as law enforcement, weather forecasters, and telecom operators. It is here that one of ANT's core research inclinations is presented to the reader in full capacity through the demonstration of the relationship between modes of existence and the establishment of those modes. In the absence of cause-effect relations, *Paris Ville Invisible* is an example of ANT's imaginary to describe a world in constant transformation, a sequence of connections and simultaneities in which each mode or entity fully participates.

It may be worthwhile juxtaposing *Paris Ville Invisible* with one of ANT's most prominent, and most frequently cited, yet, most atypical pieces: *Reassembling the Social* (2005). In this book, Latour offers a fully-fledged alternative to the traditional social theory, which he believes is prone to failure in offering social explanations. In contrast, he proposes ANT's "sociology of associations". By disqualifying traditional social theories, Latour paves the way to a "sociology" concerned with tracing the mediations that give rise to collectives. Besides its aims to position ANT in relation to social theory, *Reassembling the Social* can also be read in parallel with *Paris Ville Invisible*. In fact, the invitation is formulated by Bruno Latour himself in the opening pages of *Reassembling the Social*, and the digital version even contains a hyperlink that provides access to what is described as a "sociological web opera". In the link, we are directed to the website of *Paris Ville Invisible* offering much of what is covered in *Reassembling the Social* theoretically through a series of photos and concrete situations. We have here a multimedia essay that reflects many of the mediations encountered in the field through photography. On the webpage, one can see the city in images and signs which is, according to Latour, why it's impossible to grasp it at a glance.

Here may also lie the explanation as to why the book remained out of stock for nearly two decades without being re-edited, and why it was never published in English. The text was meant to be read alongside the photography and images in a multimedia version. The goal is to provide a journey through the hidden places which make urban life in Paris possible, or, as mentioned above, to explore *oligoptica* from which the city can be seen as a partial whole. This is achieved by juxtaposing urban reality and electronic utopias; by contrasting the real and the virtual. Beyond achievement, this

is a demonstration of how the invisible city of Paris can alter social theory. Through highlighting the fact that society is complex, both partially visible and invisible, and how knowledge and reality have never been linear, but always rely on mediations and inscriptions (i.e., maps, street signs, satellite images, etc.). Zooming out, two other themes stand out as central: the recurring theme of "composition" and the idea that Paris constitutes an assemblage or amalgam: "from the entire Paris set in one view to the multiple Parises within Paris, which together comprise all Paris and which nothing ever resembles" (p. 23, my translation). A theme that is at the core of ANT's entry into urban studies (Farías 2010).

The virtual is another topic that frequently appears throughout the book and can be depicted if we look at the rest of the citation figuring above: "we are going, in this little book, from the cold and real society, to the hot and virtual plasma: from the entire Paris …". Even though Latour and Hermant do not explicitly explain how they conceptualize the virtual, it is important to recognize it as part of ANT's analytical styles which experiments with linguistic repertoires. Not only is there a difference in how words "act" between French and English, but words become tools to think and experiment within the ANT imaginary. A demonstration of this is offered by Latour's homonymous essay, which compared to the book has an addition in its title: "the plasma" (Latour 2012). By using *plasma*, Latour substitutes the word *space*, which carries a too rigid connotation, with a more fluid concept allowing him to better grasp imaginaries of space, place and context (see p. 171). *Plasma* also allows Latour to suspend the zoom on multiple, situated "hot takes" to provide an actual background, or contexts in action – whether political, economic, social, cultural, etc. – to inquire the partial explanation of how one, or a few, of these virtual moments, or how *oligoptica* hang together. *Plasma* is a way of questioning composition; it is a way of suspending the zoom.

The new edition is now published by Éditions B42, an editor who deals with architectural books publishing in an avant-gardism style. There may be plenty of reasons why Éditions B42 is reediting the book 20 years after its initial publication with La Découverte in 1998. It goes without saying that Latour's accomplishments in disciplines including law, ecology, political science or architecture are indisputable, which is not surprising given his *a*-disciplinary generosity of thought over his lifetime and especially in the last few years. Although some of his work, not the least its ANT-fractions, have not been fully refined in response to the empirical research of the various field. Consequently, Latour's arguments sometimes become frictionless models rather than provocations to open up disciplines. Yet, rather than only being taken *à la lettre*, ANT's intellectual project, as it can be seen by *Paris Ville Invisible*, offers a repertoire full of moments, trajectories, vocabularies, and genres. The book *Paris Ville Invisible* is one of those hidden gems every ANT-*aficionado* should have in their library, even

if they do not read French. Aside from providing an array of tools for problematizing cities, as well as exploring how to conduct fieldwork in the myriad, but invisible *oligoptica* of cities-in-the-making, it is also a more-than-textual writing experiment that combines both photographic and essayistic genres. More so, *Paris Ville Invisible* is a thoughtful exploration into inventive ways of writing; it is full of tropes into Frenchness, hints at the popularisation of Paris in films, novels, and souvenirs and stands for a whole generation of ANT that is preoccupied with composing texts that reflect the heterogeneity of the worlds that are enacted.

Afterwords

The entire book review was written before Bruno Latour's passing and should not be read as an obituary but as a tribute to the broader lessons that Latour's work and ANT's early generation have taught us, especially to STS and urban researchers. Lessons for which I will be forever grateful.

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Christian Fuchs

Digital Capitalism: Media, Communication and Society Volume Three, London, Routledge, 2021, pp. 342

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Christian Fuchs's work is well known by whoever has navigated sociology of media and communication in the last fifteen years. Since the monumental *Internet and Society: Social Theory in the Information Age* (Fuchs

2007), Fuchs has continuously discussed contemporary media structures and communication practices while updating critical theory to the task, with a focus on the Internet and what he now calls Digital Capitalism. The latter is the focus of the third volume of a multi-volume series on "Media, Communication and Society" (Fuchs 2021c), a series that includes books on *Marxist Humanism and Communication Theory* (Fuchs 2021a), *Foundations of Critical Theory* (Fuchs 2021b), *Digital Fascism* (Fuchs 2022a), *Digital Ethics* (Fuchs 2022b), and *Digital Democracy and the Digital Public Sphere* (Fuchs 2022c). The prolific work Fuchs does is characterized by a few common traits that apply also to the book reviewed here, *Digital Capitalism* (Fuchs 2021c).

First of all, Fuchs's writing is essential, privileging a schematic and direct way of articulating his perspective that serves well the goals of the book. An STS reader used to forms of writing that are evocative, often ethnographically rich, and that build connections between local practices and more abstract logics, can perceive Fuchs' linearity, and tendency to summarize his arguments in tables and bullet points, as a way of limiting access to the nuances of the phenomena he focuses on. In my understanding, this perception would be well-placed if it wasn't for the second, fundamental, aspect of Fuchs' work and writing, its immense theoretical width. Only in the book I am reviewing here, *Digital Capitalism*, Fuchs includes chapters on updating, and confronting from a contemporary perspective, the theoretical contributions of authors like Friedrich Engels, Georg Lukács, Theodor W. Adorno, Henri Lefebvre, and Dallas Smythe. Those chapters open the book, and constitute the backbone of the first of the two main parts, called respectively "Theorists" and "Themes". Basically, all the books in the series on "Media, Communication and Society" follow a similar structure, with an initial part devoted to theoretical inquiries and a second part oriented toward the application of the theoretical concepts to contemporary digitalized societies. If that isn't something unexpected, as such structure is relatively conventional in academic writing, what stands as impressive is Fuchs productivity, that places him as one of the most prolific and influential contemporary sociologists of media and communication.

The aforementioned productivity wouldn't be so interesting if the quantitative aspect of it wasn't sided by a qualitative dimension that is absolutely worth engaging with. Just staying at the book object of this review, the initial qualitative aspect to stress is the definition of digital capitalism that Fuchs provides,

> digital capitalism is a *dimension* of the capitalist formation of society that emerged in the 20th century and has ever since shaped society. Digital capitalism is not a new totality, not a new formation of society. It is not a new society, but rather a novel feature and dimension of the capitalist formation of society […] digital capitalism is not just a digital practice and not just a digital structure, it is the totality of the dialectics of digital practices and digital structures that take place in capitalist society […] digital capitalism

> is an antagonistic society, which means it is a digital class society and a digital form of domination. (pp. 27, 29, *emphasis* in the original text)

From an STS perspective, especially one adopting a flat epistemology, the way through which Fuchs delimits digital capitalism can sound a little too rushed but it is in the same page that Fuchs provides a perspective that can help build a bridge between the stress on forms of domination and the empirical inquiries that characterize many STS research. In particular, it is stressing the unequal power structures that unfold in digital capitalism, that it is possible to find research directions through which Fuchs's definition of digital capitalism can be questioned and/or refined.

One of the schematic summaries provided is a classification of the three main aspects along which accumulation takes place in digital capitalism: economic, political, and cultural accumulations (for the ones with access to the book, the summary is provided in Table 1.3 at page 29). Fuchs preliminarily defines those forms of accumulation as the "accumulation of digital capital based on digital commodities" (economic), the "accumulation of decision-power in respect to the control of digital knowledge and digital networks" (politics), and the "accumulation of reputation, attention and respect by the spread of ideologies on and of the Internet" (culture). I see in this summary potential for a dialogue between Fuchs's sociology of media and STS scholarship, in particular on understanding how empirically, and in a situated manner, accumulation takes place and relates to other aspects of life and technologies. In fact, although still relatively abstract, those three definitions allow for a narrowing down and tracing in local contexts of economic, political, and cultural accumulations. For example, the political aspect can easily relate to the STS studies of digital networks and the making of computing knowledge, from managing digital infrastructures (Musiani et al. 2016; Crabu and Magaudda 2018) to hacking dominant systems (Kelty 2008; Coleman 2014).

Empirically speaking, Fuchs articulates his perspective on empirical research in one of the chapters listed as "Themes", Chapter 7, *From Digital Positivism and Administrative Big Data Analytics Towards Critical Digital and Social Media Research* (pp. 177-192). I have found this chapter resonating well with the specific standpoint from which I write, one of the atypical design researchers with training in STS and critical theory. This chapter looks indeed capable of opening up a conversation with STS research based on the critique of what Fuchs refers to as digital positivism. That is referred to as the extensive use of "big data analytics" as a way of doing research that ends up being:

> administrative [… that is] predominantly concerned with how to make technologies and administration more efficient and effective", forgetting about "philosophy, theory, critique [and…] academia's educational role. (p. 180)

After having brought into the picture some Marxian concepts of interest and the concept of digital sociology as bases for an inquiry that is not administrative, Fuchs articulates what he refers to as:

> critical digital methods [that] do not simply apply large-scale quantitative analysis to these data but use smaller samples that are analysed with the help of qualitative methods and interpreted with the help of critical theory. (p. 186)

Critical digital methods are connected, in the following of the chapter, to:

> critical moral realism in social media research [that] tries to create knowledge about social media that helps understanding what is absent in the world and needs to be created (absenting absence), in order to foster participatory democracy, freedom, justice, fairness, and equality. (p. 189)

These latter references, to critical digital methods and their research ethics, correlate, seem to me, a clear opening for a fruitful exchange between Fuchs's proposals and the ones who interpret STS as an engaged program or, like myself, who sits in between STS and design research, in which *what is absent and needs to be created* becomes one of the foci. That becomes even more evident as the book progresses, as in Chapter 10, *Capitalism, Patriarchy, Slavery, and Racism in the Age of Digital Capitalism and Digital Labour*, and Chapter 11, *Digital Labour and Imperialism*, in which Fuchs deals with issues that are at the centre of STS feminist and post-colonial reflections. In particular, Fuchs expands on the aforementioned economic, political, and cultural aspects of accumulation to point to the forms that labour – wage, slave, reproductive, and unpaid digital labour – assumes in relation to these three dimensions. The details through which those forms of labour are connected – in Chapter 10 – to different forms of accumulation, open up for what can be a fruitful conversation between Fuchs's critical sociology and STS feminist and post-colonial strands. In particular, the attention given to aspects like the means of production, the product, spaces and time of labour, its legal regulation, forms of coercion and control, and ideological stand, is an articulated proposal for further empirical deepening (for the ones with access to the book, Table 10.4, pp. 248-249, provides a comprehensive summary of these relations).

In conclusion, I think that Fuchs's book is a great one for whoever, in STS – and nearby fields like the part of design research I engage with – is willing to confront the situated research they conduct with the vast tradition that has put capitalism as the focus of study and critique, giving new steam to all participants to the conversation.

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Max Liboiron

Pollution is Colonialism, Durham, Duke University Press, 2021, pp. 216

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Laboratory studies are a popular genre within STS. Since Latour and Woolgar's *Laboratory Life*, a now classic ethnography of a neuroendocrinology lab in California (1979), STS has long been interested in science in the making. Following the day-to-day work of scientists, lab studies show that scientific knowledge emerges through the interactions between humans,

research infrastructures and nonhuman actors, including mediating technologies, pathogenic bacteria and experimental animals. Max Liboiron draws on this tradition but departs from it by foregrounding the relationship between scientific practices and the reproduction of colonialism. What is distinctive about Liboiron's approach is the use of autoethnographic accounts of lab life for drawing attention to the assumptions about land, nature and property in pollution science, and modeling an anticolonial methodology.

The author, who identifies as Métis/Michif and settler and uses they/them pronouns, directs Memorial University's Civic Laboratory for Environmental Action Research (CLEAR) in the island of Newfoundland, Canada. Once the ancestral homelands of Beothuk and Mi'kmaq populations, settled by Irish people working in the fisheries under British control, the province of Newfoundland and Labrador remains a fishing area where people, settlers and indigenous, are economically dependent and intimately related to cod. In this place where colonialism is ongoing and continuous, CLEAR's team develops open-source tools and protocols for monitoring plastic pollution in local water, marine animals and food webs. This means collecting fish stomachs, assessing the presence of plastics and disseminating research through publications and other means. The goal is finding out if and to what degree marine animals that were caught for food have digested plastics. Yet, what really matters is *how* this research practice is performed.

CLEAR, defined by Liboiron "a feminist anticolonial lab", produces science informed by the guiding principle that all knowledge is embodied and place-based, that is, emerging from specific relations to land. Here researchers are trained to address a set of practical questions with anti/colonial implications: how to collect, analyze, and dispose of fish guts in ways that honor the animal and the land where they came from? How to conduct non extractive research with local communities, indigenous and settlers, while remaining accountable to them? The lab is the primary case study for the book to examine pollution as central to colonial relations that see land mainly as a repository of resources and sink for waste. Vignettes from fieldwork, excerpts from the lab's protocols, and reflections from lab members are interspersed in the text. Liboiron uses them for examining "the role of science in achieving both colonialism and anticolonialism" (p. 36) and developing an anticolonial methodology as "a way of being in the world" (p. 1).

Pollution is Colonialism highlights the ambivalences of developing anticolonial practices in a settler colonial context. It considers the difficult relation between colonial science that assumes *land* as resource and sink, and Indigenous science that sees *Land* as the connections:

> between material aspects some people might think of as landscapes – water, soil, air, plants, stars – and histories, spirits, events, kinships, accountabilities, and other people that aren't human. (p. 43)

These knowledge systems, writes the author, "are not monolithic and stable, but rather changing, moving, patchy, incomplete, plural and diverse" (p. 130). In discussing plastic pollution through embodied and place-based perspectives, this book contributes to the robust body of feminist and Indigenous STS, including the work of Kim TallBear (2013) and Michelle Murphy (2017). These authors, central interlocutors for Liboiron, have developed nuanced accounts of colonial legacies within technoscience and interrogated their effects on people and land.

Pollution is Colonialism comprises an introduction and three chapters complemented by unusually rich footnotes that include personal details, humorous comments and acknowledgments to the book's many sources. The introduction outlines key concepts and useful distinctions. *Colonialism* is defined as ongoing access to indigenous land, concepts and lifeworlds "to advance settler and colonial goals, even if they are benevolent ones" (p. 26). Following Tuck and Yang (2012) *decolonizing* means the restitution of indigenous land and life rather than something that is done in university classrooms, through seminars and syllabi. Liboiron acknowledges that colonization is not one but many and that decolonial traditions in Latin America and Africa have long been struggling for the decolonization of knowledge. Yet, in settler colonial Canada, as well as the rest of North America, the indigenous decolonial project insists on claiming land back. In this sense, decolonial is not synonymous with *anticolonial,* a concept enacted through a diversity of claims and subject positions, obligations, and accountabilities. For instance, as a lab comprising settler and Indigenous researchers, CLEAR does anticolonial rather than decolonial or Indigenous science. It develops protocols for pursuing good land relations that "do not reproduce settler and colonial entitlement to Land" (p. 27).

Chapter 1, titled *Land, Nature, Resource, Property*, interrogates how notions of natural resource and property ownership underwrite modern pollution science since the early 20th century. In the 1910s, H.W. Streeter and E.B. Phelps, North American scientists working in sanitation engineering, conducted research in the Ohio River Valley, an area where the US Public Health Service had identified a water sanitation problem. They introduced a mathematical model for measuring water's assimilative capacity, that is, the conditions and rates under which water can self-purify from pollutants. This work laid the ground for a landmark theory of pollution: nature can metabolize a certain amount of pollution before it becomes harmful. Liboiron, however, demonstrates that this pollution model naturalizes specific land relations predicated upon the appropriation and maximum use of resources. This has happened despite the scientists' best intentions. Phelps was "a bold environmental conservationist" (p. 8) and yet he advocated for "all rivers on all lands to be governed – carefully! Precisely! – as proper sinks for pollution" (p. 9).

Chapter 2, titled *Scale, Harm, Violence, Land*, extends and complicates this critique through a discussion of the industrial chemical bisphenol A (BPA), an endocrine disrupting chemical found in plastic. It looks at scientific studies of BPA that have contested the dominant threshold theory of harm. This work, argues Liboiron, is useful for moving from the scale of harm, focusing on the action of discrete chemicals in a specific moment in time, to the scale of violence that allows to see how contaminants operate over time within industrial relations and through the interactions with other chemicals. In the case of BPA, argues Liboiron, "dominant science has provided its own critique of the hallmarks of colonial science, including autonomy, discreteness, and separation by seeing contaminants differently" (p. 97). In other words, dominant science is not a monolith but a field animated by both colonial and anticolonial impulses.

Chapter 3, titled *An Anticolonial Pollution Science*, centers CLEAR's place-based approaches for researching plastic pollution. The lab has developed methods that are committed to good land relations and informed by Indigenous science while also drawing on dominant science. For example, CLEAR's researchers have stopped using chemicals that require hazardous waste disposal even though this has posed problems for the study of plastic pollution in certain marine animals. They have crafted a model of community peer review that, although quite similar to traditional academic peer review, requires the inclusion of local indigenous groups and fishers in the decision-making process concerning the research objects and its dissemination. Rich in ethnographic details, this chapter addresses important questions about developing critiques of universalism while at the same time allowing anti-colonial methods to move across contexts. Liboiron asks, "How do place-based, nonuniversal methods travel? How do we take messages with us without being extractive or Resource-oriented?" (p. 37). These questions challenge STS to account for the ways in which "we always already are in L/land relations, and they come out in our methods" (p. 37).

The book troubles the (white, colonial) canon of STS by foregrounding the contribution of Indigenous and anticolonial scholarship. It denaturalizes the North American habit of identifying Indigenous authors with their tribal citizenship and authors of color as black while assuming that white and settler scholars are the neutral norm. So, in the same way that Kim TallBear's name is followed by her tribal affiliation (Sisseton-Wahpeton Oyate), Bruno Latour's name is followed by the term "unmarked" in parenthesis. The choice to make explicit the relation to whiteness is an invitation for authors to positions themselves, clarify where they are speaking from and what structures of privilege they inhabit. This is another contribution to the STS community and beyond to become more self-reflexive in thinking about power, privilege and land relations.

Provocative and highly readable, *Pollution is Colonialism* challenges readers, specifically whites and settlers and particularly those who like to

think of themselves as supportive of Indigenous people's struggles, to consider how seemingly innocent or well-intentioned research methods, techniques, and modes of dissemination can reproduce dominant science. The book invites to question the collective land relations of which we are all part of. While it studies plastic pollution in Canada, its generative critique spans beyond North America. Reading it in Italy, as the writer of this review did, means having the chance to reflect on the legacies of the Italian and European colonial projects. It means rethinking how European colonialism has reduced land inhabited by others to waste through patterns of power and pollution that continue today. The transnational disposal of plastic and other wastes from areas of privilege to other places, is just an example of ongoing colonial relations.

It is interesting that the book's release coincides with the peak of the decolonial turn across academic disciplines and at a time when significant questions are raised about how "decolonization" has become a buzzword within the university, often used without even mentioning the vital work of Indigenous scholars and researchers from colonized groups. *Pollution is Colonialism* directs attention to the uses and misuses of decolonial, anticolonial and indigenous frameworks in academia. For example, Liboiron notes the "rampant fetishization of nonhumans as kin" (p. 110) and reads it as a form of appropriation and redemption performed by non-indigenous academics toward indigenous cosmologies. This aspect would have deserved more discussion as it also interrogates STS's focus on human and nonhuman associations. Liboiron does not delve deeply into this particular tension between Indigenous studies and STS but invites to slow down the enthusiasm for more-than-human entanglements that characterizes much of STS and, more broadly, the environmental humanities and social sciences.

Readers of Liboiron's book, particularly outside of North America, would have benefitted from further discussion about the history of CLEAR, the financial resources supporting the lab and its relation to the Canadian state and other settler colonial institutions. This would have helped to produce a better understanding of what aspects of the lab's methods can be adapted into other contexts to develop situated anticolonial science. Notwithstanding this minor point, Liboiron's contribution is of great value for STS and adjacent fields. It shows that another science is possible, but it requires disrupting the habit of assuming land as resource and sink, and experimenting with more ethical modes of being in the world and conducting research.

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Ksenia Ermoshina, Francesca Musiani
Concealing for Freedom: The Making of Encryption, Secure Messaging and Digital Liberties, Manchester, Mattering Press, 2022

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Concealing for Freedom by Knesia Ermoshina and Francesca Musiani is the first book on encryption primarily grounded in STS. It is a much-needed book, that successfully shows how the STS toolkit can advance a socio-technical understanding of encryption, unfolding several major issues that would otherwise remain unrevealed.

Encryption is certainly among those technologies that are perceived as obscure and abstruse by most of the population. Despite the tendency to classify this technology as something for tech-savvy, activists, and war reporters, in recent years there has been a rise in media interest in the issue. Of course, the Snowden 2013 revelations – with which the whistleblower Edward Snowden leaked the existence of highly classified intelligence-gathering surveillance programs run by the U.S.'s National Security Agency and the U.K.'s Government Communications Headquarters – have been a turning point for the field of encryption that started gaining popularity also beyond the specialized circles, becoming a matter of public concern. Since then, the topic has regularly sparked interest. Recently, for instance, after European Commission's proposal to force tech companies to scan private messages protected by end-to-end encryption in search of child sexual abuse materials, several digital rights activists and watchdog organizations started to speak about the "EU war on encryption". Similar debates occurred also concerning the necessity to have a "backdoor" to open encrypted chats to prevent terrorism. Therefore, the topic is tremendously important not only for the impact it has on the personal freedoms of users and citizens but also on social phenomena that are particularly sensitive to public opinion, such as the cases of terrorism and child abuse.

The book originates from a three-year interdisciplinary research project called *NEXTLEAP*, which ran from 2016 to 2018, with the aim of deploying communication and computation protocols for a secure, trust-worthy, and privacy-respecting Internet that could ensure citizens' fundamental

rights. The Authors had two main aims when writing the book: first, to offer what they call an "analytical portrait" (p. 60) of the state of the art of studies on encryption in the messaging field; second, to conceptualize encryption through STS analytical tools and approaches. Both aims are largely achieved. The analytical portrait is rich and detailed thanks also to the Authors' deep knowledge of the field, constructed in more than three years of multi-sited ethnography encompassing participation, activisms and research in encryption circles, conferences and meeting. The Authors provide a fieldwork-driven explanation of emerging systems and communities of "mundane practices" (p. 39) through analytical thick descriptions. The STS toolkit proved all its potential in this journey. The analytical strategy deployed consists of a mixture of ANT (particularly the notions of "translation" and "enrollment"), controversy mapping of the open debates in the specialists' communities, and a more relational sensitivity inspired by Bowker and Star's (1999) work on classifications and standards. Of course, also more recent notions (such as "data activism" and "data justice") find much space throughout the book.

The book is structured in six chapters, plus an introduction that beyond setting the ground for the following chapters, offers an excellent literature review that ranges from social studies on encryption to media studies, computer science, privacy studies, and internet governance studies. The introduction also summarizes the approaches used, the research design, and the main findings of the work, but despite the appreciable effort of proposing a ready-to-use summary, it would be a mistake not to delve into the chapters. It is indeed through the excellent narrative emerging from the thick descriptions of the case studies that the Authors succeed in raising the most interesting insights, stimulating reflections in the reader, and making the reading intellectually lively.

The first chapter of the book is mostly grounded in user and privacy studies. Here Ermoshina and Musiani propose a relational conceptualization of "risk", arguing that when applied to online privacy and security, the notion is mostly a socially defined concept, that largely depends on the user's social graphs and communicative contexts. In this scenario, theoretical tools such as "threat modelling" and "risk assessment" (largely used by experts) become important operative instruments for activists, journalists, and people interested in encryption because they allow them to read the context and understand, according to their needs, what is the best choice for them.

Chapters 2, 3, and 4 are the real analytical core of the book. They aim at gaining an in-depth understanding of three different end-to-end encrypted mail and messaging applications through three case studies, selected according to their underlying protocol (centralized, federated, and peer-to-peer). Chapter 2 presents the case of Signal, a centralized application, and its homonymous protocol that is considered a best practice in encrypted messaging and has become a trendsetter for other projects in

terms of privacy and security features. According to the Authors, this protocol is a "quasi-standard" or "standard by running code" (p. 96), i.e., "something that works" (p. 61) and is iterated and redeployed by others. Centralization is understood as a "control by design" (p. 91) model – in particular, control over changes in the protocol, to respond quickly to technical challenges in situations of uncertainty. Chapter 3 discusses peer-to-peer, decentralized solutions with a focus on Briar, an open-source app that does not use centralized servers. Here the main challenges of the peer-to-peer architecture are discussed (e.g., adoption barrier and dependency on the number of users; the difficulty of managing users' reputations and identities, the role of trust within the architecture). The Authors offer a portrait also of the users of these technologies, especially activists and journalist living in high-risk environments that see a coherence between their political values, based on horizontality, mutual help, self-governance and participation, and the technical architecture of distributed networks. Chapter 4 concludes the analysis of the architectural models with federated messaging technologies, using Conversations, Matrix.org, and LEAP/Pixelated as main cases. Federations emerge as both an infrastructure configuration and a "social experiment" (p. 149), seeking a compromise between more distributed architectures and a high level of security. The federation allows users to choose between different solutions and alleviates the high degree of personal responsibility held by a centralized service provider. It can, however, present security problems due to the difficulty of auditing all the different implementations of a federated protocol. This chapter concludes with an interesting tentative systematization of the "four Cs of federation" (p. 178) (community, compatibility, customization, care), basically four dimensions of analysis for the study of federated technologies. The four Cs model is not merely a rhetorical tool, it is a valuable contribution that organizes in a useful and empirically grounded way the knowledge on federated encrypted systems beyond descriptive factual knowledge. Unfortunately, not all the chapters are along the same lines, and sometimes they tend to remain a bit over-descriptive. Throughout these three chapters the notion of "concealing for freedom" (p. 89), which corresponds to the title of the book, is fleshed out not as a fixed value, but rather as something performed differently in different situations and defined by the context in which it occurs.

After having analyzed so many technologies and protocols, one question naturally arises: how to make sense of the great variety of encrypted messaging solutions present? Inspired by the work of Bowker & Star (1999), Ermoshina and Musiani try to answer the question in chapter 5, investigating the making of the various versions of the Secure Messaging Scorecard (SMS) of the Electronic Frontier Foundation. The updated versions of the SMS gradually moved from an approach that was centered on the technical features of the tools to one centered on the users and contexts of use. The clas-

sification actively participated in the co-shaping of specific definitions of privacy, security, and encryption, placing users at the center of the classification system and giving them a more active role. According to the Authors, narratives, more than indexes, can help unveil what technological tool is the most appropriate for a specific context thanks to their reflexive power that "inspire reflection on who a person is and what they want to do, who their adversary is, and what they want their communicative act to be" (p. 208).

In the last chapter, the Authors, informed by the findings of their fieldwork, argue that the adoption of encryption in messaging systems is inextricably linked to issues of standardization, the political economy of software development, and technical architecture choices. This allows them to conceptualize encryption as a site of social, political and technical controversy.

The book succeeds in offering a compelling and rigorous overview of encrypted messaging systems and the different stakeholders that populate this field, making them accessible and comprehensible also to non-expert readers. *Concealing for Freedom* advances our knowledge about encryption, revealing political and social dynamics that certainly deserve more attention considering the pervasiveness that these technologies have and their impact in a society where much of the communication takes place through these channels. This valuable contribution fits well within the literatures on Internet governance and technical infrastructure (e.g., DeNardis 2009), from which it is inspired. The book differs from the rest of the recently published social studies on cryptography (DiSalvo 2020; Monsees 2019) because it is the first to extensively use and master with proficiency the STS toolkit to investigate the making of encryption systems. Unfortunately, on several occasions, the Authors present important insights that are not fully developed and that remain underexplored. For instance, the intuition of risk as relational is promising but *de facto* remains poorly conceptualized, and the authors seem to overlay this concept with that of contextuality, reminiscent of Helen Nissenbaum's (2010) work on privacy. The notion of quasi-standard also suffers from the same problem of underconceptualization. What is, at the end of the day, a quasi-standard? A stage before becoming a standard or a new ontological understanding of standards as less "rigid" entities? The answer does not clearly emerge from the pages of the book. Despite the convincing skepticism toward classifications of cryptographic systems, it would have been desirable to develop more of a comparative analytical dimension, which is instead left to the reader. The book lacks a chapter explicitly comparing the findings that the authors were able to observe in their intensive period of fieldwork. The goal of this analysis should not be the mere comparison of technological solutions, in search of the phantom best encryption system, but rather emphasize the different social and political dynamics underlying the making of these technologies. Furthermore, as we discussed at the beginning, governments around the world see the widespread implementation of encryption as a

threat to their ability to access online communications. Without entering regulatory issues about the legitimate reasons that governments might have to obtain the content of encrypted communications while in transit, it would have been interesting to explore how the different actors interviewed by the Authors (software developers, activists, etc.) perceive and interact with governmental actors. However, these weaknesses remain marginal in the book and point to future research paths for the scientific community interested in the study of encrypted messaging systems. The value of the book, in addition to its clarity and analytical rigor, lies precisely in its ability to point to a whole range of new research paths, making it a must-read for those looking for a technically informed understanding of how users, developers, designer and journalists are involved in the making of encrypted communications.

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