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The Hybridity of Extracellular Vesicles, Infrastructures of Identification, A Debate on 'Experimental Practice', Media, Digitization and Ecology

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The Extracellular Vesicles as a Hybrid: Life Science and its Object

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Abstract: Extracellular vesicles (EVs) are incredibly small vesicles found in the fluids of the body. Released by cells, they circulate in the body and carry different kinds of molecules as cargo; consequently, they are understood to play a significant role in cell-to- cell communication and are expected to offer potential as biomarkers and agents of drug delivery. The scientific work on them in molecular biology and biomedicine is cutting-edge, connecting production of new knowledge with expectations of new clinical applications and biotech products. This article is a case study of biomedical research-and-development collaboration on EVs in Finland. The subject of the article is the hybridity of EVs as an R&D object that is simultaneously thought of and enacted as an 'epistemic thing' and a 'technical object' (Rheinberger, 1997). In this context, EVs are a potential clinical tool, commercial product, and vehicle for upholding the continuity of research. The article argues that this kind of hybridization of research objects characterizes the practice of current life science and is closely linked to or even derived from the expectations attached to life science and biomedical research

Keywords: life sciences; objects of science; hybrid science; commercial collaboration; biomedical R&D.

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1. Introduction

In this paper, we study biomedical research collaboration on extracellular vesicles (EVs). These incredibly small vesicles – most of them are under 200 nanometres in size – are released by cells in their extracellular

environment (Raposo and Stoorvogel 2013; Palviainen et al. 2017). EVs can be found in the fluids of the body – for example, tears, sweat, urine, saliva, plasma, amniotic fluid, breast milk, and blood (Mateescu *et al.* 2017; Kalra *et al.* 2012). They carry different kinds of molecules, such as "proteins, nucleic acids, lipids and carbohydrates" (Mateescu et al. 2017, 2), as well as RNA (Raposo and Stoorvogel 2013). Several overlapping terms are used in connection with EVs – exosomes, prostasomes, oncosomes, ectosomes, outer membrane vesicles, membrane particles, and microvesicles (Palviainen et al. 2017) – but they can all be referred to as 'extracellular vesicles' (Palviainen et al. 2017, 76). Notably, "the contents, size and membrane composition of EVs are highly heterogeneous and dynamic and depend on the cellular source, state and environmental conditions" (Yáñez-Mó et al. 2015, 4).

EVs have been identified as potential biomarkers for diseases (Mateescu et al. 2017; Kalra et al. 2012). Furthermore, they are understood to contribute to "cell-to-cell communication" and are expected to have a role in disease progression – for example, in cancer or neurodegenerative diseases (Mateescu et al. 2017, 2). Their role in intercellular communication relies on their "capacity to transfer proteins, lipids, nucleic acids and sugars (…) even to sites remote to the vesicular origin", which is also why they are seen to influence "various physiological and pathological functions of both recipient and parent cells" (Yáñez-Mó et al. 2015, 2-3). In the past decade, EVs have become an actively studied subject in molecular biology and biomedicine[1]. They have been considered to offer medical potential not only as biomarkers but also, because of their ability to target very specific cells as part of cell-to-cell communication, as vaccines and 'delivery vehicles' for therapeutics (Raposo and Stoorvogel 2013; Mateescu et al. 2017; Saari et al. 2015).

In this study, we explore a research initiative on EVs in Finland in the 2010s that brought together experts and institutions from many special branches of biology and medicine, biobanks, public academic institutions, and private medical companies. The research endeavour was realized as part of a research program on personalized medicine funded by the main Finnish public innovation funding agency, Tekes. In this program, with the goal of combining scientific research with R&D (see below), funding was directed towards projects that were based on collaboration between public research institutions and private companies. Our analysis concentrates on the EVs as an object of life science in this context. We demonstrate that EVs are a hybrid object because of the way the research setting is organized and scientific work is practiced. Since the 1980s, the concept of 'hybridity' has been deployed to refer to many types of cultural mixtures in social sciences, especially in postcolonial and cultural studies (for an overview, see Frello 2012), and to assign a general cultural logic of globalization (e.g., Kraidy 2005). In addition, concepts such as 'hybrid practice' (Casper 1998) and 'epistemic hybridity' (Ning 2012) have figured in medical STS literature. We use the concept of hybridity in a nar-

rower and more specific sense to refer to the alignment and simultaneous presence of a scientific endeavour and the pursuits of clinical, social, and economic utility (see Hauskeller and Beltrame 2016a, 2016b; Beltrame and Hauskeller 2018). Such hybridity – or, rather, hybridization – can been seen to characterize the organization of research and its objectives as well as the object of research (see Cambrosio et al. 2009a). Our analysis emphasizes the collaboration of scientific, clinical, and commercial partners around a scientific object and the way such collaboration creates dependencies, constraints, and conditions for the research work, which make up EVs as an object that is shared yet manifold – i.e., a hybrid. Thus, our discussion on the 'hybridity' of the object of life science highlights the simultaneous presence of a variety of interests and objectives that are attached to the EVs and aligned through them.

Today, hybridization of organization, practice, and research objects is characteristic of many life science endeavours, which implies a profound blurring of the conventional distinction between basic and applied science (on the constructedness of this distinction, see Calvert, 2004; 2006). This can be seen, for example, in translational medicine, which does not acknowledge clear borders between clinics and labs or between research and care (Cambrosio et al. 2009b; Cambrosio et al. 2018; Tarkkala 2019). In this paper, we study this hybridity in the life sciences by focusing on expectations and manifold potentials associated with the object of science in terms of further research, innovations and applications, and future collaborations. Our approach to the EVs combines a view of the importance of expectations as a driver of biomedicine, realized in actions taken in the present (e.g., Brown 2003; Brown and Michael 2003; Sunder Rajan 2006; Tarkkala 2019; Morrison 2012), with the above concept of hybridity. Following this, our study focuses on hybridity by expectations. We ask first how the unknown and manifold potentialities in an object of life science summon a variety of actors together and modify research as collaboration. Second, we ask how hybridity by expectations influences what EVs are seen and defined to be and what trajectories and continuities of research it enables and encourages.

Our approach on EVs builds on discussions of objects of science as 'machines to make a future' (Jacob 1982; Rheinberger 1997; Rabinow and Dan-Cohen 2005). Obviously, 'future' here refers to scientific exploration of the 'unknown' in the life sciences and biomedical laboratories (Rheinberger 1997) as well as to the expected or promised applications of new knowledge (e.g., Brown 2003); it also refers to efforts to build continuity for research groups and their work (Miettinen 1998). Thus, in our article, hybridity is tied to the interplay of future making, expectations, and research tasks as they align around an object of science that is in many ways 'unknown'. Furthermore, our case of EV research is an example of a mode of biomedical science that ties academia, medical care, and the pharmaceutical industry more closely together, and our analysis highlights these intertwinements and alignments as part of knowledge production in

biomedicine (see e.g., Clarke et al. 2003; Fischer 2013; Vignola-Gagne et al. 2017). For example, social science studies on the development of cancer treatments have brought to the fore the dual role of medicines both in patient care and in producing knowledge about cancer as a disease and its pathways (Vignola-Gagne et al. 2017; Tarkkala 2019).

Rheinberger (1997) emphasizes that the emergence of scientific novelty in the laboratory requires a carefully orchestrated setting of researchers, previous knowledge, and suppliers of appropriate technologies and reagents. Extending this view, Cambrosio and colleagues have shown that novel developments and the consolidation of criteria for solid knowledge in biomedicine necessitate that work in laboratories and research sites can consistently follow specific patterns of activity, coordination, and regulation (Keating and Cambrosio 2003; Cambrosio et al. 2006, 2009b). These patterns form the basis both for the constitution of biomedical objects and knowledge production and for hybridization that blurs the boundaries of scientific and clinical work (Keating and Cambrosio 2003; Cambrosio et al. 2009a). The resulting biomedical platforms (Keating and Cambrosio 2003), with their epistemic, organizational, and regulatory patterns, enable the making of scientific futures in terms of scientific discovery and the application of new knowledge or inventions in clinical work. These futures have an additional dimension that Miettinen (1998) highlighted in discussing 'where-to' objects of research work. This concept refers to the future continuity of a research group or groups and partners of the group(s) through expanding, redirecting, and transforming their "basic activity" (Miettinen 1998, 446) while including "the societal use of results" (Miettinen 1998, 440) in their future visions and orientation. Thus, Miettinen's view of the futures in play for the objects of science is wider than that of Rheinberger, who focuses on the inherent dynamics of the practical pursuit of new knowledge in the life sciences.

In our analysis of EV research, we discuss both dimensions and also expand our scope of research objects beyond an internalistic understanding of laboratory work, in a manner that parallels Tuunainen's (2001) case study of R&D on virus-resistant potatoes. He suggested expanding on Rheinberger's work (1997), underlining that "both basic scientific concerns and societally significant applications" are at play in research work in the life sciences (Tuunainen 2001, 98); he also employed the concept of a 'dual object' to address the presence of both an epistemic and an application object in research. Similarly, Saari and Miettinen (2001, 315) have described application objects as addressing "industrial or other practical problems, in the solution of which the phenomenon studied is used", in contrast to the object proper as a phenomenon "to be understood and modeled".

These twofold concepts and analyses based on them are the basis for the discussion in this paper; however, we do not want to incorporate further dualisms to grasp the object in today's hybrid life sciences. For this reason, we discuss the EV as a hybrid research object and analyse the hybridization

of EVs in research practice, in which scientific exploration and the pursuit of clinical, social, and economic utility of biomedical innovations are simultaneous and aligned. This approach matches with that of Tuunainen and Miettinen, as they precisely address such simultaneity and overlap. All in all, our conceptual approach builds on Rheinberger (1997) and analyses that have complemented his view on objects of science and their dynamics (Tuunainen 2001; Miettinen 1998).

In sum, we study a case of EV research collaboration through 'partnership' as an example of hybridized life science research, highlighting especially the expectations involved. Collaborations are seen as the modus operandi of research work in current life sciences (Penders et al. 2015, 5), and many studies have identified and addressed an amalgamation of scientific, clinical, and commercial interests in biomedical collaborations (e.g., Cooper 2008; Cambrosio et al. 2009a; Sunder Rajan 2012; Ong 2016; Gardner, Webster and Mittra 2017; Aarden, 2017; Sun 2017; Beltrame and Hauskeller 2018). Research has shown that the partners in such collaboration are dependent on each other in terms of technical devices, finance, and epistemic authority. Moreover, Star and Griesemer (1989) have, with the concept of a boundary object, addressed how such collaboration is possible through cooperation by actors in creating a sense of a shared object, even when local flexibility and incorporation of actors' different viewpoints remain. However, as we root our analysis on Rheinberger's thinking and concepts that extend his view, our focus is slightly different. We examine collaborative R&D through paying attention to its object –in our case, the EVs. We claim that collaboration that crosses academia/commerce and scientific/clinical boundaries is essentially actualized on the level of mundane research practices. We demonstrate this by analysing how the research object is modified along with the unfolding of R&D work, as different scientific, clinical, and commercial interests and objectives are attached to the EVs. Moreover, we analyse accommodation of diverse interests and objectives in the research consortium, in which formation of the EVs as a hybrid object attached to multiple expectations and prospects is crucial[2].The novelty of our study is showing that hybridization of biomedical research (Hauskeller and Beltrame 2016a, 2016b; Beltrame and Hauskeller 2018) – i.e., the amalgamation of scientific, clinical, commercial, and social aspects – is aligned with the hybridization of the R&D object because expectations and assumptions of its potential greatly affect the coordination of research practices (see also Tarkkala, Helén and Snell 2019; Borup et al. 2006; Brown 2003; Brown and Michael 2003; van Lente 2012; Tamminen and Vermeulen 2012).

In what follows, we present our research data and the methods applied. We then move on to present the context of collaborative science in relation to our case, followed by analytical sections that highlight the EV and its hybridity as a research object.

2. Data and methods

This article discusses a case in which scientific and commercial partners came together in a research-and-development program; all partners shared an interest in extracellular vesicles and an "aim for applicability", meaning that developing personalized medicine was in their interest. The SalWe EV consortium and the partners involved form our case and site, which we will comprehensively introduce in the following section. In this section, we introduce how we ourselves approached our site and conducted our research.

The research data utilized in this article were collected between 2015 and 2017, when the working of the consortium was most intense. The data are of three types. First, there are 11 interviews with 10 informants connected in different ways with the SalWe program. Most were participants in a work package representing both industry (n=4) and academic partners (n=4), while two informants were interviewed due to their expertise in managing SalWe and SHOK programs. Because of the low number of participants interviewed, we only detail whether the quoted informant is a commercial or university partner. Some key informants were interviewed twice to get follow-up information. Second, our analysis is based on fieldnotes of observations in two public conferences where EVs were presented and discussed and in seven meetings in which project participants discussed the undertaking: how it was proceeding, what the findings suggested, the way forward, and so on. Finally, we incorporate scientific articles on EVs that contextualize, describe, and discuss the developing, technology-intensive domain of research.

We applied systematic content analysis to the research data, also utilizing the case study approach and STS ethnography in our analysis. The latter approaches helped us to contextualize the textual data of the interviews and articles, guiding us to employ different types of research data to triangulate the findings of our analysis. Comparison of interviews, fieldnotes of observations, and published research papers as well as our navigation between them allowed us to locate our findings in their context and test their accuracy.

Our content analysis of the data was fundamentally inductive, in keeping with our aspiration to 'let the data speak for itself'; however, we conducted our analysis in dialogue with literature on the objects of the life sciences: the hybridization of scientific practices, role of expectations, and organization of the life sciences into research platforms. Given this approach, we first read systematically through the interviews and other material, focusing on participants' descriptions of the EVs, of what they themselves were doing in research, and of the workings and objectives of the consortium. Three thematic framings came to the fore during this reading: 'basic science', with an emphasis on technology and methodological development, antibody development, and the EV Core facility service. During our second systematic reading of the data, we focused on what was said about EVs within these three framings, paying particular attention to two issues: first,

what the participants said they know and do not know about EVs, and second, how they characterized the EVs as an object and the potential of EVs and EV research.

In the analytical section, we organize our analysis of the EVs as a hybrid object according to the aforementioned three framings. Before that, we describe the SalWe program and the context of the Finnish EV consortium that is the site of our case study. More generally, the program is an example of a societal framework that facilitates the hybridization of life sciences.

3. Conducting collaborative science

The EV research consortium forms the site of our study. It was initiated in 2012-2013 when people from two university institutions (one biomedical, one molecular biology unit) and three companies (one producing blood products, one antibodies, and one pharmaceuticals) came together to plan a joint research effort. This consortium was summoned in the context of the public innovation promotion framework called Centres for Strategic Excellence (SHOK), administered by the Finnish innovation funding agency Tekes and funded by the Finnish government. The SHOKs were relatively independent funding bodies, and one of them, SalWe, launched a 30-million-euro biomedical program focusing on personalized medicine, of which the EV consortium was a major part. EV research was seen as a rising field in international molecular biology and biomedicine, and the participants shared the view that their main purpose was to diminish organizational and technological dispersion of EV research in Finland. Yet the initial aims of the joint effort were manifold:

> The major objective of the partners in the program is to create standardized technology platforms for extracellular vesicle studies. The novel tools and platforms can then be applied on the basic research and R&D of extracellular vesicles and the identification of EV-derived biomarkers. In the end of the project, there will be novel tools for monitoring the quality of blood products and novel sensitive biomarker methods for development of cancer diagnostics. In addition to research tools, the utmost objective of the partners is to create an active and intense national public-private network around the extracellular vesicles that will have link to international public-private researchers. (SalWe, 2013)

The work of the Get it Done (GiD) research program with SHOK funding was carried out between 2014 and 2018 and was indispensable to building up and consolidating the Finnish EV research milieu.

Within this framework, work on EVs constituted an assemblage of biomedical science focused on new knowledge and scientific methods and of R&D for seeking new medical products. The borders between public institutions and private business were blurred because the SHOKs' imperative

goal was to encourage such collaboration. Indeed, there were two conditions for funding: first, projects were to involve both public research institutions and independent companies, and second, companies had to provide half of the funding devoted to research. Furthermore, R&D priorities and the interests of the private company partners were supposed to orientate research work in the SHOK projects. This collaborative tie was not only formal; rather, it saturated the working of the EV consortium as a whole, as we will show in this article.

The Finnish EV consortium exemplifies a contemporary mode of operations for the life sciences and biomedicine. As many studies have shown (e.g., Gardner, Webster and Mittra 2017; Vallas and Kleinman 2008; Owen-Smith and Powell 2001), research on medicine, molecular biology, and the life sciences is often conducted in or closely related to settings in which science and R&D are intertwined. The two serve each other through collaboration between experts and technologies in academic or public research institutions, small and specialized innovative companies, and large multinational corporations. Research endeavours in these settings are usually embedded in a 'partnership' between public institutions and private companies for organizing, financing, and appropriating research. These are also the main features of the Finnish EV consortium.

One can often see another manifestation of the same phenomenon in the promotion of public-private collaborations in knowledge societies. In the research literature, this mode of science and its organization are referenced with terms such as 'collaborative' (Powell, Koput and Smith-Doerr 1996; Powell et al., 2005), 'mode 2' (Gibbons et al. 1994), 'entrepreneurial' (Johnston and Edwards 1987; Etzkowitz 1998), or 'marketized' (Wedlin 2008); other labels are 'triple helix' knowledge production (Etzkowitz 2008) and 'academic capitalism' (Slaughter and Rhoades 2004; Cantwell and Kauppinen 2014). Many studies (e.g., Pavone and Goven 2017; Kleinman and Vallas 2001) have suggested that the life sciences' mainstream has adopted this mode of 'knowledge production'; it has also been shown that biomedicine has become quite extensively subject to marketization and commercialization efforts in this context (Gardner, Webster and Mittra 2017; Mittra 2016; Powell and Owen-Smith 1998). Facilitated by two trends, this has developed and spread globally during the past half-century. Since the late 1960s, big corporations such as multinational pharmaceutical companies have made their R&D activities more open, seeking collaboration with academic research groups and smaller, innovative, high-tech companies (Mittra 2016; Mittra and Milne, 2013; Etzkowitz, Webster and Healey 1998). This growing openness has been congruent with the efforts of international organizations, such as the OECD, and the governments of wealthy industrialized countries to establish policies promoting science and technological innovation as part of long-term economic and industrial planning (Miettinen 2002; Powell and Owen-Smith 1998). In the landscape of 'innovation policy', science was ultimately expected to result in products, methods, or 'solutions' that would be practically useful and commercially

profitable. In practice, innovation policy in different countries encouraged the organization of scientific research into 'public-private partnerships' with academia and private companies as well as the initiation of governmental programs and funding 'instruments' to speed up the utilization of new sciences and technologies (Miettinen 2002; Powell and Owen-Smith 1998). The SHOKs in Finland were an offspring of such policy.

A collaborative, R&D-oriented, commerce-affinitive organizational model of science affects actual research practices in biomedicine (see Tuunainen 2005 for an example from the field of biotechnology). In the case we present, science and business are aligned or even entangled in the actual settings, procedures, and practices of biomedical research. Accordingly, research design, protocols, and techniques simultaneously serve many purposes in scientific exploration and in the further development of research technology, clinical applications, and commercial products. Data collection, analyses, and experiments take place in a framework of multiple definitions of objectives, results, and criteria for success or failure. In our analysis of Finnish EV research, our main interest lies in this multiplicity at work in research practice, building on a line of STS research that stresses the local practices of university research in striving for knowledge, applications, business, collaboration, and social utility (e.g., Rheinberger 1997; Tuunainen 2005; Miettinen 1998).

We argue that intensive future orientation facilitates the hybridization of research. As policymakers and funding bodies encourage and even oblige science and the scientist to be practical, productive, and receptive to economic appropriation, much or even most of the sphere has responded by becoming overtly *promissory* (Helén 2013; Petersen and Kristjansen 2015; Fortun 2008; Brown 2003; Brown Kraft and Martin 2006; Morrison 2012; Martin 2015). This response is notable especially in the life sciences and biomedicine with emerging technologies. For scientists, research laboratories, and institutions working in these fields, there are few chances to get research projects funded without augmenting proposals by promising ample prospects of solutions to grand medical problems and giving assurances of clinical and commercial applications. These expectations imply certain futures that are crucial for making and sustaining alignments between science and business and between science and medical treatments in biomedical R&D. Business and clinical rationales become entangled in experiments, and research seems to be conducted on the basis of the *potential* for profits and clinical applications inherent in biomedical exploration.

The researchers working in the EV consortium appeared to have a positive view of the hybridity – the simultaneous presence of multiple objectives – of their research. Projects that conjoin public biomedical research institutions and private companies, in which basic life science is entangled with practical objectives of developing biotechnology or applications to serve a medical diagnosis or treatment, were mostly seen as 'natural' or 'necessary' by the researchers, although they acknowledged

that EV research is not likely to produce 'medically useful' results in the near future. Nonetheless, in both public labs and private companies, researchers emphasized the collaborative aspect of the work; for them, the expansion of opportunities for collaboration is an asset of this endeavour:

> Well, it is a win-win. Synergy. Like when people have different viewpoints, different angles, and different needs … then we just get more done. There are more people with a joint interest in doing things and, on the other hand, knowledge and other resources. So we are stronger than we would be as a single group or, what is worse, as competing groups that just fiddle around with their own thing and jealously look around at what others are doing. (Research partner)

> This is purely about networking. We are a company partner, and yet it is very important for us that we have contacts with basic research, and this is a very good way to create a wider network we would otherwise not necessarily come into contact with. (Commercial partner)

Such a sentiment of 'joining forces for future gains' was widespread in research practices and settings of the EV consortium, as we will show in the following analysis. Perhaps this is why a somewhat surprising finding of ours is that tensions or disagreement between academic and commercial partners were not salient enough to hamper the work of the consortium. In this particular setting, the future orientation both in building networks and in conducting actual research tasks seemed to have the power to suspend possible controversies to the future, and allowed partners to acknowledge that their interests and objectives were diverted, although they shared expectations about the EVs.

4. The EV hybridized

The EV research consortium's objective was "to build up an internationally competitive research network in Finland to ensure high quality research and innovations in monitoring health and disease" (SalWe,2013, 99). Under this definition, a variety of scientific, medical, organizational, and commercial tasks, including the building and continuation of research work and collaboration (see also Miettinen 1998), are drawn together. Consequently, EVs are an object of multitasking. In this context, they carry the *potential* to generate discoveries in the life sciences, new tools for biomedical R&D, and new biotech products for clinical use, building research infrastructures, and sale. Nonetheless, in practice, an ethos of basic research was eminent in the consortium, as all participants seemed to acknowledge that certain scientific and technical thresholds have to be reached before any of the EVs' potential can be actualized. This had already been emphasized in the research plan:

> For solid and reliable diagnostic and clinical applications, the base of the EV technology and characteristics must be developed and established before biomarker development or novel EV-based therapies and drug delivery technologies can be developed. (SalWe 2013, 99)

In what follows, we analyse the work carried out and based on EVs. We begin by underlining the prospect of scientific novelty and the need for basic research and then address simultaneous knowledge-production and development goals before moving on to the way future continuity of research is embedded in the working with EVs.

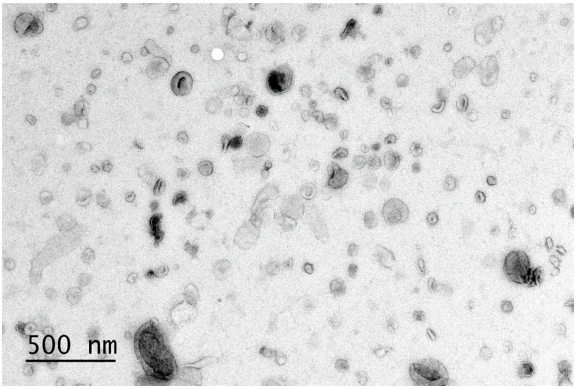

Figure 1. A picture of urine vesicles taken as part of the storage study with an electron microscope[3]. Image source: Maija Puhka.

4.1 Basic research, scientific novelty, and collaborative science

In a public lecture at the University of Helsinki, researcher Rienk Nieuwland described EVs as the "sleeping beauties of science" that contain "clinically relevant but unexplored information" (Fieldnotes, 18.6.2016). This characterization exemplifies how EVs are charged with expectations of medical applications while they simultaneously stand for scientific exploration and discovery and thus are an 'epistemic thing' (Rheinberger 1997). Epistemic things are both "material entities … that constitute the objects of inquiry" and entities characterized by vagueness, since they "embody what one does not yet know" (Rheinberger 1997, 28). In the words of Rheinberger (1997, 27), a researcher works "with a whole experimental arrangement designed to produce knowledge that is not yet

at his disposal". Finnish researchers also highlighted this aspect:

> We just had a meeting of the International Society of Extracellular Vesicles at Rotterdam. You could see there that there is hype about the utilization and application of EVs. But there is still so much we do not understand about what they are and what they do and how they work and where they go… So it is important to do basic research so that we understand what we are utilizing. (Research partner)

For Finnish researchers, conducting 'basic' work with EVs means working in a technology-intensive research field. Accordingly, a lot of their expectations focus on development work in terms of standardization, reference materials, and technology (e.g., Palviainen et al. 2017, 78). When talking about their work with EVs as 'basic research' or 'basic science', researchers emphasize the need for technologies that enable advances in scientific exploration with EVs, ultimately making discovery possible.

In Finland and elsewhere, EV research is considered a developing field. The researchers still have significant tasks ahead in terms of standardization, validation, and development of methods and techniques – for example, in the purification and characterization of EVs (Kalra, Drummen, and Mathivanan 2016; Mateescu et al. 2017; Théry et al. 2018). EV preparations become easily contaminated (Mateescu et al. 2017; Théry et al. 2018), and it is not known "how many functionally distinct subtypes [of EVs] there may be" (Mateescu et al. 2017, 2) or in how many ways they differ (Kalra, Drummen, and Mathivanan 2016, 2, 18-19). Indeed, even being sure that one has vesicles in a sample is a challenge. Thus, working with EVs incorporates the classic experimental dynamics of science, as presented by Rheinberger (1997). When describing their work, Finnish EV researchers emphasize the quest for a variety of elements that Rheinberger (1997) calls technical objects, "characteristically determined within the given standards of purity and precision". Technical objects are a precondition for experiments that might produce epistemic things, and therefore they "determine the realm of possible representations" of what is under study (Rheinberger 1997, 29). Similarly, Miettinen (1998, 431) has pointed out that "an object (a microbe, an instrument, a theoretical model, a sample of cellulose substrate) can be either a means or an object in research activity".

The consortium's scientific efforts were mainly oriented towards developing and improving technical objects in Rheinberger's sense (1997) – or the means of research activity, as suggested by Miettinen (1998) – and an EV as an epistemic thing is also necessarily implied in this view. By a focus on the improvement of methods and techniques of detection, measurement, and classification of EVs and by the setting of standards, both scientific discovery and practical applications became possible to consider

and reach for. Thus, concentration on technical objects was a priority, despite the promise EVs carry – for example, in "how they contribute to metastasis in cancer" (research partner). EV scientists in Finland were inclined to evaluate research in this field as tending to be ahead of itself, even when "basics… like storage life, measuring, and standardization [were] missing – or not missing, but deficient" (research partner). However, this tendency is simultaneously the beauty of the field.

> This is a new and developing scientific field; everything is still in development, which is rare. And that excites me; everything is new and surprising, and it's almost like whatever you find or don't find you can report as a scientific outcome. (Research partner)

The emphasis on technical objects was especially prominent in the consortium sector called 'the storage study'. This R&D work package concentrated on studying how EVs behave – that is, their quality and functionality, for example in red blood cells and platelets and in urine (see Figure 1.) – during and after storage at certain time points. The prior objectives of the study were rather practical, as a commercial partner set the task of searching for "advanced indicators of the functionality of blood products" and testing "how much information EVs can give of the condition of the blood products" (SalWe 2013, 100). This, however, was simultaneously considered basic research, essential to furthering the field. For example, rather than searching for a new blood product per se, a commercial partner wanted to learn whether vesicles could yield new information about already-existing items:

> We are trying to find out and clarify what really happens in the bag [of blood product] from the perspective of the vesicle. Quite the basics, that's what this has been all about, and then whether there is the possibility of finding a specific vesicle or certain vesicle classes – or their content – that could serve as markers. (Commercial partner)

The storage study highlighted that basic knowledge and standardization are needed in this field, in terms both of potential epistemic things and of developing and stabilizing technical objects. Even though the commercial goals in life science research are often seen as leading to more 'applied' and 'utility-oriented' science (see e.g., Glenna et al. 2011 for a discussion on the commercialization of university research), this EV project was always framed and described as predominantly 'basic research' by the interviewees. This view is congruent with the findings of social science research about scientists' different uses of the term. Calvert (2004; 2006) argues that scientists tend to describe their work as 'basic research' flexibly and with a considerable amount of ambiguity. According to Calvert (2006, 200), "scientists can use the term to protect themselves from evaluation and demands for applicability, and in this way use it to protect their interests." One way to use the term 'basic research' that Calvert (2004,

256-257) identifies is related precisely to underlining the epistemic goal of producing new knowledge on something yet unknown. Thus, 'basic research' as a description may be used flexibly depending on the context, for alleviation of pressures or creation of shared understanding about the state of the research. In the interviews we conducted, it was even suggested that given the funders' expectations of the life sciences, the kind of basic work done in this consortium would probably not have received funding in more 'scientific' funding calls. A common understanding among participants was that life science research proposals need to be 'future-oriented' (research partner) and show novelty, yet plans of further research building on the work done in the storage study seemingly lacked both elements.

> This field still needs a lot of basic research … We tried to get continued funding [for work] related to this study; the funding application proceeded pretty far, but in the end we received a rejection because it was said there was not enough novelty in this. And here we have a true misconception, because we truly have something new in it. Yet people just think that, yeah, the vesicles have been studied, but they do not realize what exactly about them has been studied. (Research partner)

R&D collaboration between academic and commercial partners provided the necessary resources for the storage study, although one research partner had the opinion that even research groups would probably not undertake it as their primary task because they "hardly consider[ed] it that exciting". Moreover, the storage study required time, and 'partnership' funding within the SalWe program was able to provide just that. Concretely, this meant, for example, continuation of employment, as the project was able to hire the people who actually conducted the analyses for the duration of the study. The data collection itself took more than two years because the samples were followed up to the two-year time point. On top of that, there were the analytical and reporting phases. Normally, "a research group does not have so much time to wait for the results", concluded a research partner.

Due to profound work in the storage study, the participants expected that the published article based on the results of the study would be scientifically valuable. They believed that this kind of research paper could be widely cited, as it would establish a common reference in the field.

> It is then a generally applicable reference that we stored our vesicles in a freezer for two years, and as has previously been shown, the vesicles survived. It is actually quite bizarre that no one has done such persevering work before, since it is the case that, for many labs, samples are kept a few years in a freezer. So everyone just assumes that the vesicles survive, but we can show that they really do. It is an important cornerstone for research. (Research partner)

However, this project was not just a safe haven for doing something that could be characterized as basic research. All the academic partners agreed that the involvement of commercial partners had an impact on the way the project was targeted and on the work carried out. The hybridization of the research object comes to the fore in the parallel necessities for an "industry-orientation" and production of "basic understanding and knowledge" (Miettinen 1998, 436). The academic partners also felt that the company partners had a different mindset, which the academics became familiar with and learned from during collaboration. Meanwhile, the company partners also acknowledged the need to create basic building blocks and undertake a both technical and epistemic groundwork for further knowledge production and utilization in the field of EV R&D. A discussion between two commercial partners exemplifies this:

> Partner A: By approaching this from a basic research perspective, we cannot go wrong. … In any case, we have displayed unequivocally that the vesicles are there – for instance, in the preparations – and they are increasing. They have significance.
>
> Partner B: This is not just in our heads!
>
> Partner A: But whether it makes any difference and whether it brings any utility in an applied or medical sense, that we do not know. But one of our goals is to find out what happens there.
>
> (Commercial partner)

In general, Finnish EV research consortium partners talked a lot about the focus on the 'basic'. However, they also saw their basic work – both scientific exploration and development of research technology – as inseparably attached to a more practical quest for EVs' usability and commercial potential. One way to understand this relationship is to think of the basic research as creating conditions for further utilization and future collaborations. In this context, the EVs appear as technical object:

> If we use vesicles as biomarkers, then that is what we are looking at right now, this aging, aging of the product: can we somehow define that with the help of the vesicles? Through either their content or the number of the vesicles? (Research partner)

The researchers also approached their work from more of an overview perspective. From this angle, they aligned the utility potential of EVs, the importance of technical objects in R&D on EVs, and the meaning of the EVs as an epistemic thing. As Tuunainen (2005, 287) wrote in his study on a biotechnology case, "theoretical, experimental and applied concerns" ran throughout the whole EV project. This involved more than just describing the same research as 'basic' here and 'applied' there depending on the audience (see e.g., Calvert 2006). An academic researcher reasoned over the manifold interests rooted in their efforts:

> At the same time as we produce utility or try to search for something the companies could utilize, we have to set up certain things so that we understand, methodologically, what we have. We cannot just take something and say that this is how it is; we have to know it exactly. And as these methods are very much in their early stages, at the same time, we have been interested in EVs in general: what they are and what they do and why. All of this knowledge has been valuable to us. (Research partner)

4.2 Biomarkers and antibodies for the clinics and for research

One of the working packages in the EV consortium was related to identifying possible biomarkers and developing an antibody[4] that could become a new product for a commercial partner. Scientific interest lay in discovering simultaneously whether EVs could be a source of biomarkers for prostate cancer and whether certain sources of biomarkers work better for the different stages of cancer: for example, whether urine is a better source for early stages and plasma a better source for later stages (SalWe 2013). Thus, an objective of the project was to study "EVs in different body fluids" to see if there was the potential to "differentiate between slow-growing and aggressive" prostate cancers by the source of the EVs (SalWe 2013, 101).

Exploring the development of an antibody, a commercial partner started to work on vesicle pools derived from the scientific partners. Some of the derived antibodies showed promise from the beginning, and one of the first tasks was to choose which antibodies would be chosen for further testing and development. As some of the antibodies seemed to recognize *something*, the task became to identify what exactly the 'something' was which was recognized.

This illustrates the hybridization of the EVs as a research object. It was approached both as a potential scientific novelty and as a possible commercial product. At the same time, the goal is indicative of the loop between epistemic things and technical objects (Rheinberger 1997). When an epistemic object becomes known and stabilized – as an antibody potentially could, once identified and standardized – it is possible for the same antibody to become part of the basic equipment on which further research and scientific exploration are built: that is, a technical object (Rheinberger 1997).

Simultaneous commercial and academic pursuits mean, in practice, that the same potential results concerning antibodies and what they recognize have a different significance for different partners. For example, a commercial partner developing and selling antibodies is not interested solely in markers for specific types of cancer or specific diseases, even if those markers were the program's initial focus. For the company, an antibody that "sticks fast and never let's go" could be optimal for development into a new product, regardless of whether it strictly relates to pros-

tate cancer. For academic partners, a good result could also be identifying an antibody and what it recognizes. In addition, an interest in these antibodies from outside the joint project raised concern over whether someone else might publish scientifically relevant results prior to the scientific partners involved in the project doing so. Concern also arose over whether further collaboration with the SalWe partners would occur. However, the company sees more data and information on the substance as greater validation in terms of developing the substance into an actual product.

A research partner suggested that the antibodies could have twofold uses. For example, no good antibodies currently exist that would widely recognize vesicles, so this kind of substance would enhance practical work in research laboratories, even if it does not make it to clinical use.

> If we found one [that recognizes antigens from the vesicle's surface], we could use it to characterize the concentration or number of vesicles or [use it] in the purification [of samples]. … But, yes, originally the idea was that the antibodies would recognize prostate cancer, and there can still be such antibodies, but we just are not there yet. (Research partner)

Thus, for diagnostic potential, the antibodies could become technical objects in the orchestration of scientific experiments. A research partner reflecting on this twofold quality said:

> I have been interested in whether something for the researchers would come up, but of course we should know what [the antibodies] recognize. And then the diagnostics is a separate thing: what can be discovered in terms of the cancer. We have two prospects here. (Research partner)

Chronologically, scientific and commercial fields do not necessarily proceed with results at the same pace. For example, commercial partners focus on patents first, which may take a long time. Scientific partners, however, must publish results as soon as possible to gain academic merit. Furthermore, what exactly the scientific partners could publish in this case – for example, regarding the antibody development – was under negotiation. As mentioned earlier, a highlight would have been actually identifying what the antibody recognizes. Even without that knowledge, however, a technically oriented publication could simply report on "how-to-do" vesicle antibodies because, as a research partner observed, "now we have shown that there are quite a lot of methods by which vesicles may be recognized". This situation also relates to working methods in a collaborative R&D project; the scientists were expected to wrap up data the project had collected so far instead of answering further questions the results presented.

Additionally, the GiD program's funding was reduced, and its duration was cut by a year in 2016. Thus, the EV consortium needed to narrow its focus. One element that was dropped was identifying a potential

diagnostic prostate cancer biomarker by sequencing cancer tissue vesicles' RNA or miRNA. The idea was to isolate specific prostate cancer vesicles from the prostate cancer tissue because other vesicles in this project originated from blood or urea. This work was abandoned, and the whole work package's prospect slightly changed because time was running out. Nonetheless, the situation evolved similarly to how the project had proceeded: the work's paths and directions were always based on results from earlier analyses, followed by an agreement on the necessary ensuing steps. This way, the object of study nudged the research interests in certain directions:

> Largely, we conduct experiments, see what kind of results we got, and then consider how to move forward with them. It is sort of like hand to mouth, the result dictates which way to go. (Commercial partner)

Identifying an antibody and its possible uses was one task that remained after the cuts in funding and project duration. It was hoped that the academics could eventually continue with the topics of academic interest to them, but, at the same time, realities had to be faced: the funds to continue might not exist outside of this work package because the "pipetting budget" of the SalWe project enabled university partners to continue without "having to think every time whether or not to do [something]" because of the price of reagents and other necessities in the work (research partner). Furthermore, funds for salaries might not exist, which would mean the expertise could disappear as people moved to other organizations and labs (research partner). The commercial partners also might be unable to continue their work on EVs because they depended on their research partners for things such as procuring vesicles. If identifying what an antibody recognizes requires vesicles, then gaining a supply while outside the joint program could become a challenge (commercial partner).

4.3 The Core facility and continuity

As noted in the storage study's context, even researchers have trouble being certain they are dealing with EVs. Multiple tests are often done to verify the analysis really studies what it is supposed to study (e.g., Puhka et al. 2017). Consequently, one result of the GiD program's work package on EVs was founding the EV Core. This continued work from other projects, but realizing a centralized facility became possible as the GiD intensified connections between involved partners. Based on the expertise of scientific partners, the Core was to be launched in 2016. In short, the idea was to help "people know whether they have vesicles in their samples or not". The Core was planned to offer expertise, isolation, quantification, analysis services, RNA isolation and sequencing, and consultation on EV studies. Equipment and machines were crucial. For example, "the espe-

cially sensitive flow cytometry" was obtained for researchers at the university and could now be utilized via the Core's service. A research partner summarized: "There are so many research groups nowadays who need concentration analysis, but do not have money nor willingness to buy the device."

Knowledge, expertise, and the ability to use devices like the Apogee A50-Micro flow cytometry or electron microscope had engendered suggestions about collaboration, so founding the Core facility service seemed a logical response in this situation. This response meant that "one could do small business and, perhaps, guarantee oneself a more stable income", instead of trying to collaborate with everyone (research partner).

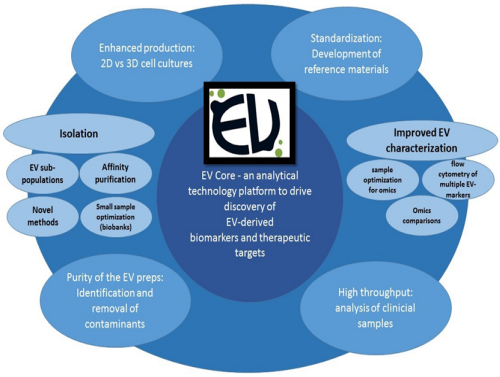

Figure 2. The EV Core as presented on their web page[5].

The EV Core started operation in 2016 (Palviainen et al. 2017) as "the world's first EV Core" providing "infrastructure, state-of-the-art and emerging EV-technologies for research groups, hospitals, companies and authorities in the EV-field" as well as "diverse EV isolation, purification and characterization services and […] contacts to various downstream analyses in other core facilities"[5]. On its web page, the Core appeared as an analytical technology platform for EV research (Figure 2). The SalWe program's participants saw the Core as a result that, according to a commercial partner, "stabilizes this field in Finland" and "internationally brings awareness that we have such a centre of expertise here". Simultaneously, the EV Core is also a space to develop, for example, isolation methods (Palviainen et al. 2017), to participate in standardization and validation work, and to gain insights into current events in the field. Along with the instruments at hand, the Core provides a chance to do research and, hopefully, to build personal career continuity inside the home institution. It also offers an opportunity to "stay abreast of what sort of things people are doing" with EVs (research partner) while simultaneously offering services that meet their

needs (research partner). In a sense, founding the Core service is simultaneously an inevitable part of *doing* research and *ensuring* the research's continuation, again illustrating the EV's hybridization. Conceptually, the EV and the EV Core include the dimension of a 'where-to' artefact. Miettinen (1998) introduced this conceptualization precisely to describe how research groups build continuation and intentionality into their work.

The Core's main goal is not to make a profit per se (Palviainen et al. 2017, 78) as long as it can "sustain itself" (research partner). Moreover, the Core's technological intensiveness is inseparable from expertise intensiveness. The Core connects specific expertise with specific technologies and devices as it aligns partners to collaborate with each other:

> There are vesicles. But since we still do not specifically know precisely what they are, this EV Core is unquestionably important […]. It should be developed and invested in because, as said, this field is so difficult, requiring specific equipment and instruments, the development of the instruments, of analytic software, everything like that for us to [make it work] […]. We cannot distribute this to many different places in a country this small. (Commercial partner)

At the end of the SalWe program, the continuation of the EV Core facility service faced a challenging situation. Continued funding was not guaranteed for researchers who had been hands-on during the analyses. Thus, how to move forward was uncertain, even though laying the foundations for continuity was one prime goal for establishing the EV Core in the first place. Additionally, the key researchers' expertise with the equipment and with hands-on work with vesicles proved to be the Core's actual asset.

> This Core, certain devices are connected to it. But, first and foremost, we, the researchers, have the expertise, which cannot be taken away from us [even] if we give the devices to someone who knows how they work but not how this is related to vesicles. … There have to be the people who know what to do with them, and both of those instruments are really challenging, not easy to automate, like press this button and the answer comes. Instead, you have to understand how you adjust them, how you put the settings, and what you get out of it, and then there is still a lot of tuning up. And then, for example, how to purify them [vesicles] so that contamination will not become a source of error. We measure really small particles that contaminate if your buffers are, for example, not filtered. Yeah, we cannot, for instance, take people here to measure with those devices without first educating them extensively about how to do it. (Research partner)

The urgency related to funding was especially connected to expertise. Funding cuts tend to yield a situation in which personnel are no longer available when funding returns; such a situation "would require us to get

the same people back; we cannot start this all again from nothing" (research partner). The above block quote emphasizes that expertise combining technical and scientific matters with craft cannot be adopted overnight (see Meskus 2018). A research partner explained that, even with someone eager to learn EV techniques and interested in joining the EV Core's crew, considerable time is needed to master the devices and the craft.

> You learn with your eyes and you learn from different samples. I am also learning all the time while I work, but I have a lot of grounding with which I can compare. So it is a bit… I might have time to educate a new person on some level, but in order to offer someone's work as a Core service, that requires time and careful consideration. (Research partner)

Along with the availability of expertise and skilled personnel, the fast pace of technological development posed a challenge – technological development makes instruments and devices outdated eventually. In this sense, a research partner stated a need to "step on the gas", because the interest in the EV Core has been promising, but more efficient and better equipment will enter the field at some point. To progress and stay relevant, one must follow developments, receive funding, and keep skilled persons on board. These issues are crucial for the EV Core to stabilize itself as a long-term, meaningful, well-known, and high-quality service.

5. Conclusions

Our analysis of EV research in Finland shows that, because science and R&D are entangled in the financing, organization, and everyday practices of EV research, the EVs are simultaneously thought of and enacted as many kinds of objects. Therefore, they are a *hybrid by expectations*. The EVs act as a genuine scientific object, 'an epistemic thing' (Rheinberger 1997). Their physiological functions and the biological mechanisms in which they are involved are not fully known; consequently, scientists think pursuing 'basic' research on EVs may lead to scientific discoveries in molecular biology and biomedicine when technology and research methods allow for new knowledge to be crafted. At the same time, researchers are working on stabilizing EVs and on the methods to observe and manipulate them, so EVs can serve as a tool for scientific research, 'a technical object' (Rheinberger 1997) enabling new knowledge and discovery. Technical and epistemic stabilization, or even standardization, of EVs also has a clinical arm. The expectation of EVs becoming biomarkers for detection of, for example, cancer and EV-related biotechnology becoming clinically useful are central to the research of the Finnish EV consortium. The clinical aspect closely relates to the commercial one: for company partners, research on EVs allows the development of EV-related products

for biomedical research and for the clinical market. From their perspective, EVs as biomarkers associate with a future biomedical commodity[6].

Finally, the EVs as research object are enacted in the Finnish consortium as something upon which to build the continuity and sustainability of this life science specialty (Miettinen 1998). By developing and maintaining the EV Core as a SalWe project spin-off, EV scientists believe they can strengthen their research's financial and scientific foundations. They reason that providing technical services and expertise in research methods for 'EV issues' to other biomedical research groups can sustain research collaboration, help them follow developments in the field, and even gain revenue. This would enable further development of the SalWe project's work and reinforce the position and capabilities of Finnish scholars in emerging life sciences and biotechnology fields.

The EV object has prospects in all these fields. Within biomedical R&D, the EV's promise includes various modalities. Epistemically, the EVs are unknown and have potential for scientific novelty; as prospective biomarkers, they offer promise or even a 'dream' of clinical and commercial utilization; as a stimulus for developing research techniques and methods, they support sustainability. EVs exist and are worked upon primarily through their potential, reflecting an overall orientation towards choreographed 'future making' (see Rheinberger 1997) in EV research and in biomedical R&D. Academic and commercial partners both repeatedly emphasized this collaboration's predominant 'basic research orientation', but the rhetoric of future uses and benefits brought focus to diagnostic and clinical utilization in a life science project. The current work simultaneously performs the expectation of eventual translation even while the work concerns taking the first steps in the domain. A research partner of the Finnish EV consortium pointed out this configuration:

> When thinking about applying for funding and so on, the applications must be very future-oriented, and so when the grant applications are written the potential usability of the results [in the future] must be very thoroughly thought through. One always tries to consider the potential usability of the results, but especially when it comes to the specificity of this field in which even the very basics are still part of the search, the preservation of samples is extremely important to know and explore. (Research partner)

Notably, the aspect of future-making also seems to have the power to prevent tensions regarding hybrid practices and alliances in EV research from escalating and thus paralyzing the project. As researchers share an idea that they are working upon something in a state of becoming, the EVs can simultaneously exist as many kinds of objects (scientific, technical, clinical, and commercial), which does not cause a problem with R&D activities because potential controversies or mismatching goals need not be resolved now. In other words, looking forward allows the suspension of such matters.

In a parallel way, the focus on the technicality of EV research facilitated the maintenance of unity and the solidity of the consortium's work, which had multiple directions. It included and aligned scientific pursuits, efforts to develop items or methods for clinical or commercial use, and the organization of a facility providing biomedical research services. According to the researchers, the EV is predominantly a technical matter in these three areas. They emphasized that work on EVs primarily concerns technology and methods. Consequently, the crucial question concerns what is allowed by research techniques and devices, whether expertise exists in certain analyses and methods, how EV preparations were crafted, the available reagents, and how to validate the results. Technicality provided a common ground for the consortium partners' diverse pursuits.

> B: We all have our own [focus], but then we share the object of study…
>
> A: In this work package, there has been a good situation because it is so clear that we all have our own interests, so we do not have worry. We can share the whole technology topic. We can share many things...
>
> B: … and all the results we get.
>
> A: Yes, because we know that we all have our own domains, but then there is also the intersecting zone. (Commercial partners)

To conclude, the hybridity that characterizes much of contemporary life science results from the amalgamation of elements and domains usually considered distinct: academic and corporate elements, public and private elements, scientific quests, clinical utility, and commercial pursuit. This subverting of traditional boundaries concerns the financing and organization of research and its concrete practices and objects. As our analysis of Finnish EV research shows, hybrid research practices simultaneously pursue various objectives, and the object of the research is manifold. Therefore, the practice and the object of life science again show the conventional distinction between basic and applied science is less apt to describe the actual undertaking.

Two of our observations on such entanglements are particularly important. First, the promissory ethos with which EV research was imprinted and the emphasis on its technical character were crucial for unifying the heterogeneous elements and objectives of EV research and mostly prevented epistemic and other tensions. Second, subverting the demarcation between basic (academic) and applied (clinical and/or commercial) research did not subsume the scientific quest to clinical or commercial utility. On the contrary, research and commercial partners saw EV research as an emerging and immature life sciences field, so they emphasized that the consortium's work was predominantly 'basic science'. The rationale was that biomedical companies need basic knowledge of EV science, and the academics were there to provide such knowledge. A bit surprisingly, academic partners were very content with the financing and

collaboration the hybrid formation provided. This arrangement allowed them to do 'basic science' via investigation and experiments focused on the basic biology of the EV and via basic research techniques and methods. According to them, such research 'lacks novelty' and is therefore unlikely to attract public research funding. However, this work also provides the only route to the expected innovations.

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[1] A search in PubMed reveals that there were 219 matches for the term 'extracellular vesicles' in 2008, whereas in 2018 there were 2,333 matches (https://www.ncbi.nlm.nih.gov/pubmed/?term=extracellular+vesicle, 22 May 2019). A search in Web of Science points in a similar direction, with matches rising from 209 in 2008 to 2,462 in 2018 (https://apps.webof-knowledge.com-/RAMore.do?product=WOS&search_mode=GeneralSearch&SID=F6To3PL5pRKjctlbHze&qid=1&ra_mode=more&ra_–name=PublicationYear&colName=WOS&viewType=raMore, 22 May 2019).

[2] Studies on bio-objects have also discussed the hybridity of objects in the life sciences (e.g., Vermeulen et al. 2012). This work has underlined that bio-objects "tend to disrupt the conventional boundaries and identities of biological forms and categories" (Metzler and Webster 2011 649), such as animal and human or viable and non-viable; thus, the concept helps to show the openness of "boundaries around "the living" (Holmberg, Schwennesen and Webster 2011, 742) and the movements "backwards and forwards between different life-statuses" (Webster 2012, 2). This discussion emphasizes that bio-objects are also characterized by their status as "contested socio-technical objects" (Holmberg, Schwennesen and Webster 2011, 741) and highlights processes of bio-objectification that engender such status and contestation in actual settings of research and usage. Our approach to the hybrid character of life science objects is in many ways affinitive to the ideas of bio-objectification, especially where organization of science is transformed (Vermeulen 2012). In this paper, we highlight the *practical* hybridity of the R&D object derived from the amalgamation – or hybridization – of scientific, clinical, commercial, and social objectives in the work of the life sciences.

[3] Electron microscopy is a characterization technique used in EV studies that also allows researchers to visualize and quantify the EVs present in a preparation. The scale of the image is in nanometres, which are one billionth of a metre.

[4] Antibodies are produced by the body in response to, for example, disease, and in this way their presence can be used for diagnostic purposes and to indicate the composition of certain samples.

[5] Available at https://www.helsinki.fi/en/research-groups/extracellular-vesi-

cles/ev-core (retrieved 17.9.2018)

[6] Despite apparent similarities, the research object's 'hybridity' discussed in this paper differs from Annemarie Mol's (2002) idea of multiple ontology of diseases. She claims that a disease as a medical object is multiple or "more than one and less than many" (Mol 2002, 82) because of various enactments upon a disease in different medical practices and sites via different devices. This specific kind of ontology is not our focus. Our analysis of the EVs' hybridization emphasizes the collaboration of scientific, clinical, and commercial partners around a scientific object, and we focus on how the collaboration creates dependencies, constraints, and conditions for the research. This moulds the EVs as an object that is shared yet manifold, i.e., a hybrid. Our discussion about the hybridity of the research object highlights the simultaneous presence of various interests and objectives aligned through the EVs.

Moving Bodies: Creative Infrastructures of Identification

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Abstract: This article empirically analyses how the unknown bodies of migrants who died in the attempt to reach Europe are managed and potentially identified. Shifting attention away from the border, the paper provides a new angle to the crisis unfolding in the Mediterranean, investigating the practices developed in order to know and attend to the dead migrant's body. More specifically, drawing from 6 months of ethnographic fieldwork conducted in Sicily in 2016 and 2017, the article presents an ethnographic account of the emergent Italian forensic infrastructure. It does so by looking at movement. The movement of bodies towards identification. The pursuit is informed by Science and Technology Studies (STS); the focus is on material practices aimed at the eventual identification of unknown bodies. Taking stock from recent debates in the anthropology of infrastructure in which scholars critique the idea that infrastructures are passive architectures comprising circulations, the paper proposes an alternative perspective on infrastructures, arguing that infrastructures are processes of constant and creative adjustment and that these ongoing changes are the effect of circulation.

Keywords: circulation; anthropology of infrastructure; identification; dead bodies; migration crisis

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1. Introduction

> Se questi morti sono soltanto nostri, allora io voglio ricevere i telegrammi di condoglianze dopo ogni annegato che mi viene consegnato. Come se avesse la pelle bianca, come se fosse un figlio nostro. (Giusi Niccolini, Mayor of the Islands of Lampedusa and Linosa, "Appello all'Europa", 2012)

This piece is about infrastructures in the making. I'll give away the end at the very beginning (spoiler alert!). Contributing new threads to anthropological studies of infrastructure, the paper argues that infrastructures are processes of creative adjustment and that these ongoing changes are the effect of circulation. More specifically, foregrounding the circulation of bodies in the infrastructure whose purpose is identification, I show the infrastructure is enacted through the very movement of bodies and bodily material. By the end of this journey I hope that what movement *does* will become clear. But now let's start from the outset.

In summer 2016, at the beginning of my fieldwork, the word *infrastructure* was not part of my vocabulary. My object of research, I explained, are the procedures and activities involved when the dead body of a migrant is found, recovered, investigated, and buried. My focus is on the identification apparatus supporting the forensic and scientific practices mobilized to give a name to the unidentified migrants who died on their way to Europe. Such a cumbersome speech wasn't very helpful. I had to develop better communication strategies. I started using the term *forensic infrastructure*. It was all there, in two words: the kind of organization that must be in place to know and attend to the dead migrant's body.

The topic was indeed not popular. Amidst the putative "refugee crisis", whilst political (and academic) attention was on the European frontiers and border management regime, I studied an aspect of the phenomena that was largely overlooked: the management and identification of migrants deceased in the attempt to reach Europe. Engaging with the first qualitative study on the Italian forensic infrastructure, I investigated the initiatives taken to attend to and eventually identify the dead migrant's body. The aim was to uncover the trail followed by a body with no name. A *how* question triggered the research, and echoes in this article. What kind of path does the body of a dead migrant travel, and how does this route come about?

The pursuit is informed by Science and Technology Studies (STS); the focus is on the material practices aimed at the potential identification of unknown bodies. Attending to forensic work in practice, in fact, reveals the traits of motion, uncertainty and flux that most define and characterize the complex scientific endeavor of identifying a body without a name. Whereas on paper identification procedures follow a linear trajectory from the place where a dead body is found to its burial, on the ground, the supposedly fixed infrastructure loses its extraordinarily defined features, exposing a reality filled with ambivalence. In investigating the socio-technical landscape required to manage and potentially identify the bodies of dead migrants, this manuscript aims to take this very ambivalence on board, unravelling the movement of a deceased body through its identification route within the forensic infrastructure.

It is important to stress from the outset how the theoretical framework

of this paper challenges the rationalistic assumptions of the 1970s studies in which infrastructure was seen as a passive "substrate" and takes its cue from emerging and innovative models that highlight the relational nature of infrastructure, exploring its agentic and ontological potential (Star and Ruhleder 1996; Karasti et al. 2016; Jensen and Morita 2016). In fact this manuscript provides an empirical analysis on the emergence of infrastructure, answering the question of how infrastructure comes into being. To answer this question I draw from M'charek (2016) the concept of circulation, or movement, two terms that from now on will be used interchangeably. Movement is to be understood no longer as a simple transmission of people and things from one place to another, rather it is herein engaged as a performative event that co-shapes humans and things as they move through space and time (M'charek 2016, 29). Contributing new threads to STS interest in this field, the piece sheds new light on our understandings of infrastructures, showing how infrastructures emerge creatively through the doing of movement itself. I start by introducing the problem of border deaths. The paper then familiarizes the reader with the issue of forensic identification making use of the protocol as ethnographic and heuristic device. Next, I situate the topic within recent debates in anthropology of infrastructure. After clarifying the theoretical and methodological stance, the analysis is fleshed out empirically, providing ethnographic accounts of the Italian forensic infrastructure.

2. Dead bodies at the border

In recent years the intensifying flows of migrants attempting to reach Europe have been receiving increasing attention. The numbers are indeed unprecedented: the pro-democracy uprisings of the so-called "Arab Spring" in 2011 significantly mobilized cross-border movements as people fled violence, persecution and political turmoil. For the most part, the European response to the migration's upsurge took the form of security and militarization. Whilst the human flows have been framed primarily as a threat - through a rhetoric of invasion and emergency- a collaborative effort at a European level was made to protect the borders, not the people (M'charek 2018). Interventions focused firstly on the containment of migrants, asylum-seekers and refugees in the Southern Mediterranean, and, secondly, on intensifying border control and surveillance policies through the mobilization of a border enforcement agency, Frontex (Carrera et al. 2012, 4).

Politics of border externalization were set up to prevent arrivals particularly in the Mediterranean Sea, on land along external EU borders and within third-party states such as Libya, Turkey, Moldova and Ukraine (Jones and Johnson 2016). The "collateral" effect of such policies

was to produce a segment of the world's population who risked their lives to get inside Europe (Van Houtum 2010). The construction of barriers did not stop people coming, it simply directed them elsewhere, forcing them to choose more dangerous and deadly pathways each time. 20,000 migrants have died seeking to cross the Mediterranean since 2014 (Dearden et al. 2020). From 2017 to 2019 the deaths recorded are 5,600, of which more than 4,300 died on the Central Mediterranean route, most typically departing from Libya and aiming to reach the Italian territory (Robins 2019). Despite a decrease in the absolute number of deaths and disappearances recorded on the Central Mediterranean crossing, the probability of dying while crossing the Central Mediterranean has increased (Dearden et al. 2020).

Despite the repetitiveness and magnitude of the deaths around Europe's southern borders, the dead receive little or no attention from state authorities. Questions relating to who the dead are or their origins are seldom raised, little is known about them or their names – the cause of death is not even counted or registered officially by governmental organizations. There is no established common practice for collecting information on migrant deaths between States, data on irregular border-crossers is limited, and there are no official death tolls (Laczko and Brian 2016; Last et al. 2017). While the management of borders and their protection is implemented through a collaborative effort at the EU-level, the issue of identification and management of the dead is left to chance, dependent on the competences and individual abilities of local public authorities (police, the public health system, courts, cemetery attendants) in the place where their body is found or brought from the sea (Tapella et al. 2016). Politically ignored, deceased migrants are left unattended and unidentified.

Slowly but gradually attempts have been made to counteract the inaction of states and fill the information deficit. The Mediterranean Sea is at the heart of the epidemic of death and Italy is the country of first arrival on several routes across the southern external borders of the EU (Last et al. 2017). By exploring the ways devised to manage and know these bodies along Italy's southern borders, this paper offers a different understanding of the human crisis unfolding in the Mediterranean. If the insistence on borders implies a disconnection between realities, a "here" and a separate "there", conveying the idea of divided worlds, the bodies of the people who have died while attempting to reach Europe show that the problem is not outside, but it is *our problem* as well. Making the people, rather than the borders, the matter of concern (Latour 2004), may well start with thinking bodies as agentic participants and remind us of the power asymmetries of the European Union's border management regime.

3. Identification

Pointing attention to the regulatory gap surrounding dead bodies at the border, the first Conference on the management and identification of unidentified decedents, with an emphasis on dead migrants, was held in Milan in 2013[1]. Two years later experts from the forensic community met again in Barcelona[2]. The main objective of these meetings was to start an international dialogue on the problem of unidentified dead migrants. The agenda included: 1) to share information on migration problems in different Mediterranean countries; 2) to improve communication, cooperation and coordination between the different entities involved; and 3) to identify "best practices" at regional, national, and international level. There indeed is no easy way to identify an unknown body.

Following international regulations, identification is based on the comparison of *post-mortem* (hereafter PM) data, which is information taken from the corpse to be identified (medical and/or dental information, fingerprints, DNA, clothing, and circumstantial evidence) with *ante-mortem* (hereafter AM) data, which includes information relating to the missing person before his or her disappearance (medical and dental history, distinctive features and unique characteristics of the person, clothes and other personal items worn by the missing person when last seen). Matching PM and AM data may lead to the identification of an unidentified body (ICRC 2013; ICRC 2017; Cattaneo and D'Amico 2016). Making this comparison, however, involves a rather complex work of coordination, made even more complicated in the case of migrants who have died while traveling: if PM data can be collected directly on the unidentified corpse, the collection of AM data has to be done with the families and acquaintances of the dead, whose country of origin is often unknown.

Subsequent to the conferences, Italy is so far the only country to have adopted at an institutional level specific protocols for the identification of deceased migrants (Piscitelli et al. 2016). This initiative did not come out of nowhere. In October 2013 two shipwrecks occurred in front of the Island of Lampedusa where it is estimated that more than 600 lives were lost (Robins 2019,19). On that occasion the Italian governmental office of the Extraordinary Commissioner for Missing Persons joined forces with academia to identify the victims retrieved from the sea. A couple of years later, the night of April 18, 2015, a vessel carrying migrants sank in the waters between Italy and Libya, leading to the deadliest shipwreck ever

[1] Supported by the University of Milan, the Italian Red Cross (IRC) and the International Committee of the Red Cross (ICRC).

[2] "Second Conference on the management and identification of unidentified decedents, with an emphasis on dead migrants: the Experience of European Mediterranean countries" supported by the ICRC and Spanish Red Cross.

recorded: 28 survivors, about 800 drowned. The mass disaster stretched the capacity of the Italian state to respond, again. Later that year *Operation Melilli* – named after the nearby coastal village – was launched, to recover and identify the victims' bodies. A task force – comprising forensic pathologists from twenty Italian universities, experts from the ICRC; engineers; professionals from the Navy, the police, the fire brigade; and local governmental authorities from Syracuse – was created ad hoc (Piscitelli et al. 2016). A protocol was designed formalizing the collaboration between the government and University[3].

Starting from the protocol devised for *Operation Melilli,* the paper examines the emergent Italian forensic infrastructure. As an organizing device the protocol helps forensic practitioners to standardize a procedure through which data can be linked to a body and finally a person. The protocol does not simply describe the work that goes into identifying dead bodies, it also orders and organizes that work (M'charek and Casartelli 2019). In a similar way, by focusing on how the protocol acts as an ordering device, I use it as an ethnographic device (M'charek and Casartelli 2019, 741) to unravel the complicated and contradictory process of identifying dead bodies.

Even though the *Melilli* protocol refers specifically to the victims of this shipwreck, the document is representative of how the identification of unidentified bodies is assumed to work in general. Indications provided are fully in line with the DVI (Disaster Victim Identification) protocols of Interpol (designed for mass disasters) and the ICRC International Committee of the Red Cross (ICRC). The document describes the whole set of forensic activities to be carried out on the unidentified body to optimize the collection of PM data. A well-preserved cadaver, for instance, is photographed with metric references, from all angles. Then clothing and personal belonging are removed, described, and registered. Distinguishing signs or marks, like tattoos, scars, and implants are recorded. When possible, fingerprints are always taken, x-rays and a 3D scan of face and skull are made. Through an autopsy the biological profile of the corpse is construed. From all cadavers a DNA sample (could be a tooth, the femoral diaphysis or a piece of the iliopsoas muscle) is retrieved, and if present, a hair sample (Protocol 2016).

The document lists the identification procedures a corpse undergoes to collect PM data. The process implies the allocation of a multiplicity of specialists, radiologists, forensic anthropologists, odontologists, and geneticists. Different instruments and apparatuses operate together. The process involves epistemological, technical, as well as legal and bureaucratic aspects. All the information collected must be transcribed, orga-

[3] The Melilli protocol sanctions an agreement between the Ministry of Education, University and Research (MIUR) and the office of the Government's Extraordinary Commissioner for Missing Persons.

nized and stored. Doctors communicate with authorities, authorities communicate with technicians, technicians with undertakers. Different realities and worlds are entangled and connected to one another. This complex intertwinement, collaboration, and distribution of such diverse practices is something that we may call *forensic infrastructure*, and precisely the object of this investigation. But what exactly is an infrastructure? And why is the term useful? The following section answers these questions.

4. Roads

No prior boundaries exist to define infrastructures (Star and Ruhleder 1996). Infrastructures are complex systems, characterized by ambiguity, incomplete information, cooperation by different individuals and often bring together a diversity of actors, organizations, and perspectives from academia, industry, commerce and the general public (Karasti et al. 2016). Infrastructures were first conceived as a "substrate":

> Something upon which something else "runs" or "operates" such as a system of railroad tracks upon which rail cars run. This image presents an infrastructure as something that is built and maintained, and which then sinks into an invisible background. It is something that is just there, completely transparent (Star and Ruhleder 1996, 112).

A common metaphor associated to this perception of infrastructures is a road which allows the movement and traffic of cars. Once they are built, roads are "out there", time quietens and cars glide along the way. Accordingly Larkin defined infrastructures as "built networks that facilitate the flow of goods, people, or ideas" (Larkin 2013, 328). One wonders, however, whether this exhausts our understanding of infrastructures. Drawing from literature that highlights the relational nature of infrastructure, I endeavor to explore infrastructure's agentic and ontological potential (Star and Ruhleder 1996, Karasti et al. 2016; Jensen and Morita 2016). Rather than passive backgrounds underlying social action, as they are conventionally viewed, the article conceives infrastructures as generative systems, that both organize flows *and* spin out new relations between them (Jensen and Morita 2016, 3, emphasis original). Infrastructures have world-making capacities, they *give form* to culture, society and politics (Jensen and Morita 2016, 3). Situating my research within these conversations, this article goes beyond, or perhaps, behind, the issue singled out by the Authors. Focus will not be on what infrastructures are able to generate, but on exploring the very emergence of infrastructures.

In order to do so, I borrow the concept of circulation, as delineated by M'charek (2016). Ever since Mauss (1924) anthropologists have stud-

ied the movement and analyzed the cultural meaning circulations transmit as they traffic people and things. Moving beyond mere transmission, the analysis will look not just at the things that move, but at the very *doing* of movement. Circulation will be hence engaged as a *performative* event that brings about identities and changes humans and things as they move (M'charek 2016), showing the effect of circulation in the very making of infrastructure.

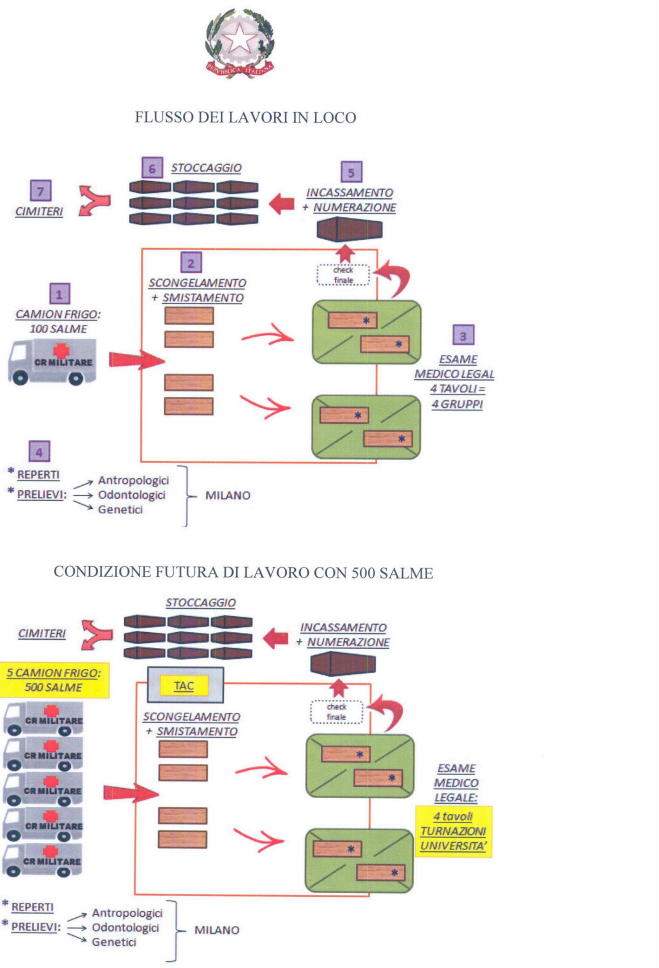

Image 1. "Work flow on site", Technical Annex, guidelines for managing the unidentified bodies of the shipwreck of April 18, 2015.

Movement is indeed implied within the forensic infrastructure. Let's take a look at the following picture. Image 1 (see the next page) is taken from the Melilli protocol and describes the trajectory the bodies were to follow for the purpose of identification. The diagrams order temporally the work-flow and the division of labour among the different practitioners (M'charek and Casartelli 2019, 744). Starting from a refrigerated ICRC truck (1), the body bags were moved to an area where they were defrosted and sorted (2). Then they were transported to tents where autopsies and external examinations took place (3). The anthropological, odontological, and genetic samples retrieved were sent to Milan (4), whilst the corpse would be boxed in numbered coffins (5), stored (6), and then distributed to cemeteries around Sicily (7). The second diagram shows how this order is not expected to change even under working conditions where 500 bodies are expected.

As we can see the circulation of bodies is entailed in the whole process, yet somehow lacks specification. The protocol presupposes a linear road along which the body travels from the refrigerated truck to the autopsy table to the grave, easily changing hands and available for examination (M'charek and Casartelli 2019). Seemingly bodies appear on a mortuary slab and are smoothly moved from site to site and from hand to hand, readily subjected to several identification activities. Samples are retrieved, stored at room temperature and transported to laboratories where they are subjected to further analysis to complete the biologic profile of the corpse. For every corpse a photographic digital archive is created, and information fluidly travels and is transcribed on international forms both Interpol and ICRC. Each corpse is followed by a legal practitioner, an anthropologist and an odontologist (Protocol 2016). Referred to as a "road-map" (Piscitelli et al. 2016), the document is illustrative of the tendency to engage infrastructures as systems which regulate the traffic of things, people and information. On paper, the forensic infrastructure is a fixed design in which dead bodies are smoothly managed and moved for the purpose of identification. In reality, however, the movement of an unknown dead body is far messier[4].

Once we start looking at movement empirically, the established route slows down, accelerates, bends sharply, or disappears. Zooming-in on the circulation of bodies and bodily material entailed in the identification infrastructure, I will take you on the route the body follows towards its identification. Exposing the detail of forensic activities in practice this article shows the very different configurations this road takes on the ground. As bodies start moving the road starts changing. As will become

[4] STS has long been interested with the theoretical and methodological challenge of mess. Nowhere is the endeavor greater than in the messy world of large-scale collaborative science projects. See Buyuktur and Jackson (2014), and Law (2004).

clear in what follows, infrastructures do not emerge *de novo*. Much infrastructural work has already been done and made durable in time. A focus on circulations, however, offers a new perspective on infrastructural activity. Infrastructures have erroneously been seen as a stable "matter that enables the movement of other matter" (Larkin 2013, 329). Instead, this research will show that it is the opposite: the very movement and circulation helps to shape the infrastructure. It helps to shape the matter and the specific version thereof.

5. *Rammendo*

Following the movement of the body and bodily material in the road towards identification I engage with a methodological genre developed within STS called *material semiotics*. This approach looks at reality as a dense *material–semiotic network*. That is, we are caught up in sets of relations that have to do both with meanings and materials. Nothing exists outside the enactment of those relations, therefore, to understand reality we must explore the multiple webs and the material semiotic practices that carry them (Haraway 1991; Law 2004).

With these conceptual and methodological arguments in mind, the analysis attends to forensic procedures unravelling the mundane practices of the identification endeavor. In the Melilli protocol we have encountered various versions of the body: as a corpse, as a tooth, as a bone, more bones, a DNA sample, a garment. The infrastructure to identify an unknown body indeed entails a wide range of virtual, technological and physical crafts that take the human body to construct meaning in relation to its identity. If reality is *not independent of the apparatuses that produce it* (Latour and Woolgar 1986) the technologies that use the body as a means for identification produce very different renditions of the body. The body, once again, comes in many versions (Mol 2002). Tracing out the diverse ways in which the body is made knowable I suggest the identity of an unidentified body is not a fact to be revealed, but an intervention on the body that comes about in practices. A photograph, a fingerprint, a 3D scan.

At this point I would like to elaborate on a visual metaphor, that of embroidery, in Italian, *rammendo,* that is particularly apt to articulating the qualities and complexities of the identification endeavor I describe. During my fieldwork the moments of concretization of the forensic infrastructure were far from obvious. Characterized by invisibility, mess, and ambiguity it was not easy to assess and circumscribe my research object. Drawing, *inter alia*, on Haraway (1991) Law (2004), and de La Bellacasa (2011), methods don't just describe social realities but also help to create them. Reality does not precede the mundane practices in which we interact with it (Mol 1999, 65). Law and Singleton (2005) employ the meta-

phor of fire to describe a pattern of presences and absences. Construing through a material semiotic approach my research object, I observed and became part of something evoking a darning of torn pieces, moments, words. The word *rammendo* signifies both the work performed with the needle on the fabric and the operation, the *practice* of darning, the one in and out movement of a threaded needle. The job is not glamorous, its ontological existence is not taken seriously (Pérez-Bustos 2017, b).

Similarly, identification of unidentified migrants is a careful work in relation to bodies and materialities. Collecting forensic evidence from a dead body is a meticulous work of care and shares the invisible status that characterize some textile craft activities. Like mending a destroyed cloth, it takes time, patience, and handiwork. A forensic pathologist, a friend, told me a Sicilian proverb that she related to her job: "you eat onion. Your eyes weep, and others get angry"[5]. By shedding light on the practical and affective commitment with the becoming of these bodies, this paper aims to make an intervention, becoming part and co-constructing a *rammendo* of different designs and colours sewn together.

Ethnographic material comes from 6 months of ethnographic fieldwork carried out in 2016 and 2017, following the movements of deceased bodies of migrants back and forth between laboratories, cemeteries, and mortuary slabs. Nineteen semi-structured interviews were carried out with forensic pathologists and anthropologists. Furthermore, key actors of the forensic infrastructure, including activists, ICRC volunteers, police officers, lawyers, undertakers, politicians, a representative of the International Commission on Missing Persons (ICMP), and the Italian Extraordinary Commissioner for Missing Persons were interviewed. Whenever possible, observations were made in forensic laboratories. In addition, fieldwork included a day of participant observation in the military hangar in Melilli, where identification activities of Operation Melilli were taking place. I worked closely and befriended some coroners from the Universities of Palermo and Catania, getting to know them, seeing how they work, exchanging points of views, and sometimes observing autopsies and external examinations of corpses. This paper is based on very different ethnographical cases of identification, that are more or less part of standard practice. We start from Operation Melilli, the retrieval and identification of the bodies drowned the 18th of April 2015.

6. Operation Melilli

Whilst the protocol overlooks the retrieval of the corpses, as if it were indifferent to the identification work *per se*, I believe it deserves our at-

[5] Personal Conversation with coroner, January 2017.

tention. Operation Melilli started with the deployment of the Navy's underwater special operation unit[6] recovering 169 corpses scattered in an area of 1,805,000 m² on the sea (Trucco and Ibba 2016). In the meanwhile, the intervention strategy for the retrieval of the vessel and the bodies inside was planned. 9.5 million euros were financed by the Presidency of the Council of Ministers for the operation[7]. The underwater enterprise was entrusted to a private company, the *Impresub Diving and Marine Contractor*. All steps were carefully organized. A preliminary inspection of the wreck was carried out through a Remotely Operated Vehicle equipped with sensors to assess its exact position (370 meters below the sea level), and the geological characteristics of the seabed. A robotic underwater unit was designed and built for the occasion. The cyborg was controlled from the surface through a futuristic co-management console from which most of the underwater operations were handled. The support able to accommodate the equipment and technical personnel for the execution of this unprecedented operation was selected in a Multi-Purpose Supply Vessel, the *Ievoli Ivory* (Trucco and Ibba 2016).

In fact, the high-tech aspects of the enterprise were not always suitable to real conditions. Prohibitive weather and sea conditions represented a substantial limit to the continuation of operations as an optimal weather window of at least five days was necessary for the robotic arms to pull the boat up. Recovery operations started in April 2016, a year later the shipwreck. When dealing with the movement of bodies climatic factors must be taken into account, and not just to plan the retrieval of the corpse. The conservation of a dead body is crucial as it provides precious PM information, and it largely depends on the interaction of the body with environmental conditions. During the long time spent in sea water, the bodies underwent a conservative cadaveric phenomenon called saponification, in which the body is encased in a waxy material called adipocere slowing down the decay process: the internal organs and external features of the corpses were hence discretely preserved. Once removed from wet or moist conditions, however, the decomposition of the body would resume quickly.

To mitigate the tissue alteration that the putrefaction process entails, when the vessel reached the surface it was kept at a temperature around 5°/10° through the use of liquid nitrogen. The nitrogen also helped to drive away sea birds targeting the bodies, until the wreck reached the port of Augusta, where a NATO military base had offered to temporarily host the ambitious project to examine the bodies with the aim of identifying them. The medical and forensic activities were organized in an enormous hangar inside the NATO headquarters. The ICRC provided three

[6] GOS Gruppo Operativo Subacquei.

[7] Sources are contradictory on the exact amount spent to retrieve the wreck.

refrigerated trucks, two tents for autopsy examinations and forensic procedures and a refrigerated container to store all biological samples and personal effects. A military base was transformed into a forensic laboratory. Still, the bodies were unavailable. Trapped inside the boat, the presumed 800 bodies had to be taken out: a hole was made on the hull. A group of firefighters was specially trained by the forensic pathologists to ensure that no element useful for identification was dispersed during the removal of the corpses. Recovery operations were particularly complex because the boat's holds and engine compartment were narrow, difficult to reach, with very small accesses. The firefighters took care of one another. They entered two at a time. One would collect the body, the other would check on the colleague, ready to intervene in case of need. With the help of shovels, the firemen collected 7 bags of objects useful to the recognition but not specifically attributable to any particular body, 36 containers of bilge sewage possibly containing some clues, and 457 body bags of *commixtio tremens,* that are commingled human remains.

As we can see, cadavers do not simply appear on an autopsy table ready to undergo the collection of PM data. Migrants' bodies are found in various places: washed up on beaches, trapped in fishing nets or in rocks at the bottom of a cliff, clumped in ships holds, scattered at sea (Tapella et al. 2016, 57), or hanging from trees[8]. Operation Melilli points at the work it takes to *move* a dead body from where it is found, as it cannot be left as litter in the sea or on a beach. Indeed, there is no easy way to move 800 corpses from 370 meters under the sea. The kind of work necessary is varied: ranging from the creation of sci-fi robots to the work of care that induces a firefighter to look after his colleague, to wipe dirt off his face or quench his thirst whilst securing body parts[9]. Each of these details is not trivial but essential for the movement of bodies. Diverse qualifying efforts are required to move a dead body. Although such operations may not immediately seem to be linked to the identification effort, they are a crucial part of the forensic infrastructure. Once bodies start moving, they impose modes of relating to them. They help to produce the kind of infrastructure through which they can be transported. *Although taken for granted, movement is key to identification.*

7. Emergence

Operation Melilli unfolds a bricolage of different actors that enable the corpses' transit, both human and non: politicians, vessels, soldiers,

[8] Personal conversation with forensic anthropologist, January 2017.

[9] In the documentary "Lontano Dagli Occhi", Domenico Iannacone interviews the firefighters who retrieved the bodies of the victims of April 18.

shovels and liquid nitrogen. As bodies move many things start moving with them. Looking closely, we see old and new elements intervene in the enterprise. This was not the first time a large-scale pilot study to identify dead migrants had been undertaken in Italy. The approach was framed by the shipwrecks of 3 and 11 October 2013 (Robins 2019), that provided the experience operationalized in the intervention strategy deployed in Operation Melilli. The technology used had a history as well: the private company supporting the Navy in the operation had tested its technical capacities in the recovery of the Albanian vessel A-451, sunk in the Adriatic Sea on March 28, 1997, at a depth of 800 meters, where Albanian migrants lost their lives (Trucco and Ibba 2016). These two occasions laid the foundations for testing and refining the technology used in Operation Melilli. We see how infrastructural work is not built anew but emerges incrementally over time, developing from existing infrastructures that both enable and constrain their form (Star 1999). New elements may become part of standard practices, others, may not. To clarify another example is provided. The same summer, not so far away, in the court district of Trapani, another vessel was being perforated. A coroner I spoke to recalls the episode:

> I was expecting a call for that night... I had heard the news. There was an unknown number of corpses on a boat rescued in international waters, then transported to the port of Trapani. Our duty was pretty straightforward: the prosecutor had ordered to complete autopsy operations and attempt personal identification of all the corpses in 48hours. There were rumors about deceased migrants trapped in the hold. It was impossible to check the accuracy of such rumors due to all the migrants on the main deck, waiting to be transferred on KBV 001 Poseidon. Even once we reached the deck, we couldn't see anything in the cargo. It was very hard to look inside, extremely narrow, low in height and without ventilation. After 150 Migrants had been transferred we found an unconscious migrant and started CPR, without results. There was no heart activity. We continued for around 20 minutes before we had to redirect our priorities to all the other migrants who were unconscious or in very bad shape. When more migrants were moved we were finally able to investigate inside the cargo. A colleague crawled inside the cargo. He found a body with vital bodily functions and determined all the other migrants were deceased. The migrant who showed signs of life was reallocated. When all the unconscious migrants were stabilized we decided to recover the deceased bodies. To be able to do so, we had to open the deck. We opened two big holes, one in the bow and one in the

stern[10].

The case described in the ethnographic vignette is different from the previous, and indeed less notorious. However, the issue is akin: the retrieval and identification of deceased bodies. In this circumstance, legal action triggers the bodies' recovery. There currently is no fixed regulation in Italy through which authorities must proceed to identify a cadaver. As clarified by Tapella et al. (2016, 58) identification is too often dependent on the initiative and know-how of the individuals who conduct the forensic investigation. In fact, there is no legal obligation to perform an autopsy or to identify a person who was not a victim of crime. The performance of a full autopsy is at the discretion of the *Pubblico Ministero* (Public Prosecutor), who appoints the judiciary police and the coroners to conduct the forensic investigation into the identity of the cadaver and the cause and circumstances of his/her death. While identifying the bodies of drowned migrants departs from the criminal justice context, both systems aim at standardized procedures, that are thought to guarantee proper handling from the start. As a device, a protocol helps forensic practitioners to achieve a level of standardization, setting out a procedure through which data can be linked to a body and eventually a person. The question is how that work is done on the ground, where standard procedures do not hold (M'charek and Casartelli 2019, 740).

In this specific case the Prosecutor had ordered the coroners to carry out autopsies and external examinations in 48 hours. Their first concern, however, was to take care of the migrants who still showed vital functions. Only when the stabilization and relocation of all the passengers, almost 200 people, were completed, the doctors could dedicate themselves to the deceased bodies. 52 bodies were retrieved from the cargo storage and transferred in a refrigerated van. As previously mentioned, refrigeration is essential as cadavers are not immune to the summer's heat and decomposition rapidly advances. Also, a refrigerated van keeps the smell of the corpses under control. By chance, that night, the forensic team acquired a refrigerated truck confiscated from the mafia during a criminal investigation occurred a few days before[11]. The van temporarily joined the chain to facilitate the transportation of bodies. That night the forensic team transported all the corpses to the cemetery where the requested examinations were performed. Under such circumstances, the lab moved to the graveyard.

The example of the truck accidentally confiscated from the mafia is significative, as we see an unexpected actor become part of the forensic

[10] This case was also part of a Power Point presentation presented by Antonella Argo at the IX National Conference of the Italian Group of Forensic Pathology, October 2016.

[11] Personal conversation with coroner (January 2017).

infrastructure, then disappear. Looking at the how the movement and circulation of bodies comes about in the identification endeavor, discloses an infrastructure that is more fluid and flexible than what we may think, a process that adjusts according to specific needs emerging in a particular time and place. A *creative* infrastructure, we could say.

Image 2. The forensic team whilst unloading the refrigerated van

Image 3. Photograph of the whole team during forensic operations in the cemetery

8. Creativity

> You've got to be domestic right? Ok... so we used a coffee cup to clean the teeth of the cadavers and whiten them like the odontologist explained, we put some bleach so they became a little cleaner… 'cos she was annoyed (by the fact that) they were all dirty 'cos it's not like we had time to brush all the teeth one by one, right? I mean, there was no time to do what one would have probably done in the case of one single body… so I said let's put them... you see... I had kept the coffee cup... by chance... I said let's put them in the coffee cup... (the coffee) offered by those who provided the coffins, those men, the undertakers, how can I call them?

The fragment reports part of my conversation with Paola, a forensic pathologist participating in Operation Melilli. Incongruously with the media portrayal of the enterprise, the collection of PM data was carried out in a situation of financial dearth and paucity of material means. Whereas for the sci-fi retrieval of the ship 9.5 million euros were provided, no funds were allocated for forensic operations. The identification effort was seen as an act of humanitarianism, a contribution of expertise that permitted universities to engage publicly with the issue of deaths in the Mediterranean Sea. At the same time, it provided ample opportunity for research and training (M'charek and Casartelli 2019, 748). In the excerpt above Paola is describing how a coffee cup becomes a tool for identification procedures. Teeth are of particular importance in the identification process. When examinations on the body are impossible or insufficient for the identification of the cadaver, the odontological inspection and the comparison of the anatomical and pathological peculiarities of the buccal cavity can give more decisive results. Faced with the necessity to ensure properly cleaned teeth were quickly handed to a bothered odontologist, Paola ingeniously places them in a bleach filled coffee cup.

On another occasion, one of the forensic anthropologists was annoyed that while cleaning the bodily remains, small bones kept disappearing in the sink. After a year under the sea the bodies had commingled together. One of the aims of the forensic work was to understand how many people were on the boat, and the bones were important traces in this process of counting. Although the bones were not registered one by one, they were taken into account in order to understand the magnitude of the disaster and to create a registry of the number of victims. The disappearance of small bones down the drain complicated matters. One day she came up with a solution. Part of her lunch was a fresh ricotta cheese. Walking back into the hangar she put the ricotta basket into the sink and was happy to find that it fitted perfectly. It thus became a sieve to catch the small bones (M'charek and Casartelli 2019, 272). The two examples describe

ways to adapt the infrastructure, revealing a situated and continuous process of re-composition, in motion. The infrastructure adjusts to the body's needs. Far from stable and *a priori*, the infrastructure is tinkered with (Mol et al. 2010) all the time and different elements are tailored to conform for the body's circulation to keep going. We find that existing infrastructures, such as the coroner's lifetime experience, adapt to new and difficult working environments. Next unusual ecologies, like a filter from a package of cheese are enrolled to ensure the bodies' circulation and become crucial devices in the forensic infrastructure.

This is not to imply that the making of the infrastructure is vague or random. Far from it. When asserting the infrastructure comes into being through the interaction and adaptation of various elements I do not mean *any* kind of feature can appear to facilitate the bodies circulation. Rather I highlight the creative process that is infrastructure, in which different actors change and fine-tune to solve contingent demands. Long-established features readjust through the body's circulation. A military hangar becomes a forensic lab to receive 800 corpses. Everyday objects, such as a coffee cup, intervene to allow teeth to be adequately treated. Or less "trivial" interventions, like a van confiscated from a criminal scene helps to transport bodies ensuring their preservation, becoming part of the identification infrastructure. As novel entities emerge, they may dissolve into the background, like the hangar provided by the Navy in the port of Melilli turns into a military base again once identification activities are completed, or yet again become durable. I wonder where the coffee cup might now be.

In the following ethnographic vignette, I am inside the hangar, helping with the registration of clothes. When the firefighters accessed the cargo of the vessel, scattered clothing and objects were found, probably the passengers' luggage, randomly gathered in bags separated from the corpses. These personal belongings were not immediately ascribable to any corpse but were classified anyway, after which they were recorded and photographed. I was instructed to take notes as the bags were opened. This was not an easy task: words were dictated to me at a particularly high pace, flies were going in my eyes and inside my mouth. The job was quite demanding for a newcomer.

> I shoo away the flies from my face, nose, and hands. I'm taking notes for myself, when I can, on my arm. Some garments are more intact, lending themselves to a more meticulous description, others are reduced to shreds. My pen is dirty and smudged. Smudged with rotten remains. The coroner starts speaking very fast, and I concentrate on writing in capital letters in a readable calligraphy:
>
> BAG 04, CARGO
> 11/07 TIME 11.27. YELLOW PLASTIC BAG AT THE OPENING OF WHICH CLOTHING IS FOUND.

INCLUDING
BROWN JACKET WITH EXTERNAL LATERAL POCKETS ANTERIOR AND INFERIOR (EMPTY).
INSIDE COVERED WITH FAKE FUR.
BRAND: UNREADABLE
SIZE: XL
BLUE AND WHITE SHOE WITH SYMBOL
BRAND: NIKE
SIZE: 41

> The coroner opens a sweatshirt and I see something falling out, it rolls on the floor. I lean over to look, it is a bone, I indicate it to a man from the scientific police who picks it up and puts it on the table with the other remains. I will register it under the entry "dispersed find", a piece of cervical, C2.

Movement is capricious. By falling down C2 evokes the contingencies in which bodies move. As the bone inscribes the ethnographer into the forensic infrastructure, it indicates the quality of the infrastructure's emergence: an adaptation of the different elements that allow the movement of bodies. C2 tells us something else as well: by moving within the infrastructure, bodies move and change, and also change things and people around them. Circulations are so much more than a transmission from point *A* to point *B*. Movement means change.

9. Change

In Operation Melilli the firefighters had been trained by forensic pathologists not to leave out any useful information when they crawled inside the vessel to retrieve the corpses. This is particularly important because when a body is found it is the body itself that is the source of data, and everything around it. This is the case not only in cutting-edge operations such as the one occurred in the Port of Augusta:

> Port of Catania, 3 a.m.
>
> Click. Click. Taking pictures are two operators from the scientific police. Click again. A young forensic pathologist joins in. She knows what to do. She has done it before. It is crucial to immortalize the body as soon as possible, shoot the face while it is still there. She puts on her gloves and helps them drag the body, clumped amongst others, closer to the moon light penetrating from the hole on the roof. Noticing the presence of a foam coming out of the corpse's mouth, she slightly turns the head so the picture fully captures the froth. Click. Then she cleanses it with a tissue. The cadaver is reproduced more than once from repetitive angles. They look inside the clothes and in the near surroundings

> for any information apparently connected to this cadaver. She collects the fingerprints. An operation that usually goes beyond the tasks of the forensic doctor, being relevant to the Scientific Police. Fingers are well preserved, they all probably died just a few days ago. The corpse with all its personal belongings is moved inside a body bag. Time for the next one.

The moment the corpse is found, evidence is sought mainly in the circumambient of the body. The search involves the corpse, the clothes, the close environment. Often evidence is secretly secluded in necklaces or in the hair! *Don't ever forget to check the pockets.* As soon as the body is found, everything counts as a factor. The body itself, skin and flesh, but also all that is outside: personal effects, documents, jewelry, sim cards, phones. What is missing is also important: fingers devoid of nails, children without parents. The body reaches its amplest peaks as contextual information is taken. Proof is everywhere as evidence is sought in the background and through circumstantial information, but there is not much time. The body must be moved. Relations of space and time will change as the body keeps on moving.

> Cemetery X, 9 a.m.
>
> The zipper is opened. She starts looking. It's incredibly hot. Her colleague is outside the tent smoking a cigarette. They have been working all night. He is humming a song he heard on the radio, a summer hit. She smiles, then starts attentively inspecting the corpse in front of her. The body is lying in a supine position with a rigid support under the nape. She looks for distinctive elements or particular marks on the black epidermis. She finds nothing. No special mole, piercing or tattoo. No external injuries, scars, or traces of old surgeries. The only thing she takes note of: he is circumcised. She then cuts off a lock of hair. After securing it in a plastic bag she takes the scalpel and performs a cut at the level of the pelvis. She raises some bundles of the iliopsoas muscle with surgical forceps. She notices the brownish looking muscle has lost its normal consistency, as it is easily divided by the scalpel. She withdraws a piece of it for DNA analysis.

This fragment depicts a forensic external examination. Once the cadaver is removed from the context in which it was found, practices to identify it can proceed more calmly. The surroundings don't count anymore. Elements that may contribute to finding the bodies' identity are now sought on the body. Its exterior is the fount of data pertaining to the skin, the fingers, the nails, the wounds - inside the mouth, on the teeth. Biological samples are retrieved. A lock of hair and a piece of the metaphysis of the femur. Not only biological samples are retrieved from the body. Photographs of details or particular signs are taken, fingerprints (if not done before), garments and personal effects are collected and stored

away. Throughout identification procedures we observe a multiplication of the body (Mol 2002), as examinations take the body and articulate it into the source for forensic identification. The following excerpt describes an autopsy.

> Once the surface is checked, the body can be opened up. It tells more. They start from the head[12]. The scalp is opened: pericranial soft tissues are detached and skin flaps reversed. From the left frontal region samples are taken and placed in a sterile container, a specific box that ensures proper conservation pending the histological examination. Her colleague performs a cut with a circular saw, he removes the skullcap and clutches it with two hands. After extracting the duramater, which is free of injuries, they observe the encephalon. It is in an advanced state of putrefaction. They retrieve anyway it and place it in a box for future dissection in the lab. She then takes the scalpel and deeply carves the skin with a long incision from the upper part of the neck to the suprapubic area...

Whereas before evidence was looked on the body's surface, information is now found *inside*. The body "shrinks". Through incisions, the body is exposed, cut and dissected. It reduces in space, but it is gaining time. *The body is transient.* Although the protocol suggests a neat temporal and spatial orientation, once the body is subjected to forensic examinations it undergoes a process of spatial compression and temporal expansion. As samples are progressively retrieved for laboratory examinations, tiny bits of the body become part of other networks and travel long distances. Whilst the corpse is handed to undertakers that arrange the burial, photographs and fingerprints crystallize it in archives of the scientific police, as it enters digital databases through Interpol and ICRC forms. Documents pile on the desk of a magistrate. The femoral diaphysis goes to a laboratory for DNA analysis. Skin tissues undergo histological examinations, and so on. Legal, physical, bureaucratic, and forensic investigations intertwine as the body is translated (Mol 2002, 35). Pictures, biological samples, the fingerprints, the files and the clothes are what the "body" is at the end of the identificatory route. From physical to material, from written to digital, the body on its route towards identity is transformed. It has become smaller yet acquired an abiding durability.

10. Conclusion

In the context of the putative "refugee crisis" thousands of people have died *en route* to reach Europe. Moving away from the lenses and

[12] Alternatively, autopsies start from the rib cage, usually with a "Y" cut.

politics of the border, this article offers an alternative approach to the crisis in the Mediterranean, exploring the scientific endeavor to know these corpses and confront their anonymity. Attending to the management of deceased migrants in Italy and identification initiatives surrounding dead-bodies-at-the-border, this paper dealt with the issue of forensic infrastructure. My argument in this piece was about adding further articulations to the issue of infrastructure. Whereas infrastructures have traditionally been viewed as passive substrates affording movement, I invited the reader to challenge this common way of thinking about infrastructures, offering insights in the becoming of infrastructures. Utilizing the protocol as an ordering device, the paper analyzed movement empirically and disclosed the reality of forensic work *in practice*, showing how infrastructures are processes of constant adjustment that emerge creatively through circulations.

Here I have focused on circulations and what circulations do. At the end of this journey, I hope to have convinced the reader that movement is so much more than a simple passage from here to there, and that the performative powers of circulation deserve our attention. Movement is change. It turned coffee cups into forensic utensils, professionals into volunteers, and it made me an anthropologist of science. But this is another story. This work also provided knowledge on the management of dead bodies of migrants. Mobilizing the visual metaphor of *rammendo*, I disclosed the factual and affective commitment with the becoming of these bodies, refusing the silencing of these deaths. In conclusion, inquiring the scientific efforts to attend to the dead migrant's body, this article aims to subvert the unacknowledged massacre and advocate for the existence and the possibility of change. For while these bodies move, they might also move us.

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When Experimental Practice Comes First

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Abstract: This article hosts a vivid discussion on Papadopoulos' book *Experimental Practice. Technoscience, Alterontologies and More-Than-Social Movements* (Duke University Press, 2018). This is a speculative and politically engaged book. It crosses the boundaries of social theory, science and technology studies, feminist theory and autonomist thought. The following contributions explore and critically discuss an essential topic of the book: the role of movements and everyday practices in transforming eco-societies from below. Andrea Ghelfi situates the book in an historical contingency in which social transformation is primarily driven by material, ontological transformation. Luigi Pellizzoni offers an analysis of the ambivalences of experimentalism in a context marked by neoliberal governmentality. Roberta Raffaetà brings attention to three interrelated themes: practice, theory and the role of institutional power. Finally, Dimitris Papadopoulos' response focuses on the complicate relation between practice and politics in more-than-social movements.

Keywords: social movements; ontological politics; technoscience; posthumanism; practice.

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Introduction

Andrea Ghelfi

Experimental Practice. Technoscience, Alterontologies and More-Than-Social Movements is a book that explores the many links between technoscience and movements. The author, my friend and teacher Dimitris Papadopoulos, takes seriously the multitude of implications in thinking politics, or better a politics of justice, in a historical context marked by the deployment of technoscience. The first implication of this phenomenon is the decentring of the humanistic subject: Papadopoulos situates his book within the wider understanding of the human-nonhuman continuum that characterises the culture of the early twenty-first century. The continuous folding of everyday life, science and technology into each other – something that we learnt to call technoscience – here is seen as the main drive of the posthuman culture. But instead of mapping the multitude of theoretical approaches that in various academic fields are offering different versions of this 'more than human' turn, Papadopoulos accumulates in this precious book a significant series of concepts, ideas and practical examples for mapping and imagining radical politics within the posthuman condition.

Papadopoulos' work resonates strongly with Haraway's concept of technoscience. In her words in fact technoscience disarticulates the imaginary time called modernity, signifying a mutation in historical narrative, "similar to the mutations that mark the difference between the sense of time in European medieval chronicles and the secular, cumulative salvation histories of modernity."(Haraway 1997, 4). Technoscience exceeds the 'modern' distinctions between nature and society, subject and object, the natural and the artefactual. New configurations of knowledge and practices emerge in the midst of this implosion of boundaries, included new human-nonhuman assemblages grounded on the experimentation of alternative forms of life. Papadopoulos sees in the end of humanist culture and in the decentring of the human in relation to the material world, technologies and other species, a condition of possibility supported also by the desire of escaping humanity in favour of richer forms of sociomaterial composition and multispecies Earthly cohabitation.

In the Italian context we had a few occasions – I am thinking, amongst others, to Pellizzoni's book *The New Mastery of Nature. Ontological Politics in a Disposable World* and to the seminars organised by the group Politics Ontologies Ecologies in Pisa in the last three years – for discussing the multiple relations between technoscience, ontologies and politics. This book can offer a significant contribution to this discussion starting from three central ideas that crisscross it:

1. Technoscience regards practices as human-nonhuman activities that shape the material configuration of worlds and constitutes an his-

torical contingency in which social transformation is primarily driven by material, ontological transformation.

2. Alterontologies constitutes the key field of experimentation for organizing a political posthumanism.

3. Insurgent posthumanism configurates an intelligibility of movements irreducible to the categories of modern politics.

In the next sections I am going to highlight, albeit in a rough way, these three key hypotheses emerging from *Experimental Practice*.

Ontological Politics

A central thesis of the book consists in the idea that in our technoscientific era production has a double meaning: the construction of new ontologies and the insertion of them inside scales of value. The term 'biofinancialisation' here designates not only an economic strategy or a new regime of accumulation that emerged in the Global North after the crisis of Fordism, but also a culture of permanent valuation pervading society and the everyday life: any aspect of sociomaterial life and the environment enter into this indeterminate and unstable process of evaluation that feeds the movements of financial markets and financialised societies. The universalising matrix of financial value is a logic in which the future is universal and exploitable. Biofinancialisation is the financialisation of life and matter. Following Papadopoulos' argument, the characteristic core of biofinancial accumulation consists in the very fact that "biofinancialization becomes *molecularized* in flesh, in code, in matter. It alters the composition, the material infrastructure, of bodies and forms of life […] biofinancialization becomes the ecology of terraformed existence more so than just a system for accelerating accumulation" (2018, 41). In the global economy not only every resource and service provider will be counted, but as HSBC Bank analysts remember us "food chain and the supply chain will merge" (2018,42). We are witnessing at the becoming rent of Earth beings, animals, plants and ecosystems. A disposable world, saying it with Pellizzoni, is the outcome of a process of biofinancialisation that transforms the material tissues of everyday life since the ecobody of Earth is not separable from the current architecture of accumulation. The frontiers of productionism and the frontiers of matter merge in natureculture: here lies the actuality of ontological politics in technoscience. Ontological politics are the specific practices that perform the inclusion of new formations of matter into the accumulation regime of current economies. In a historical contingency in which technoscience and the processes of biofinancialisation are making worlds and rearticulating forms of living and dying in natureculture, politics becomes ontological politics. At the same time, as we will see, the ontological terrain constitutes for Papadopoulos the key field of experimentation of other ways of being and for organizing alternative possibilities of world making, alternative materialisations.

Ontological politics, or better alternative forms of ontological politics, doesn't require primary new forms of representative politics, but new practices of making; other forms of life bringing certains humans and certains non-humans together in more sustainable ways. Alternative materialisations, not alternative representations: on this terrain of intelligibility, it is possible rethinking a constituent politics in technoscience. But what does constituent mean in a present characterised by the proliferation of the sprawling net of natural-social-technical associations and by the implosion of the 'modern' chronotope? How can we think politics beyond the categories of modern political thought? And, what kind of intelligibility of politics emerges from the idea of 'alternative materialisations'? Papadopoulos proposes a reading of Marx's *Economic and Philosophical Manuscripts* based on a definition of political activism grounded in an understanding of materiality: all that exists is matter and each transformative activity is material. Which means that matter itself cannot be conceived as an outside or an object of human practice: matter is humanity's body too. Matter is a vital force and inorganic as well as organic life are movements of matter. In this context, activism and matter are conceived simultaneously and a collective activism is defined by its capacity to affect material change. If the several trajectories of technoscience create new ontologies, new worlds and new forms of life, a politics of alternative materialisation refers to the plurality of possible engagement in a specific socio-material arrangement. Following Papadopoulos 'politics here means that by performing only one of the existing options rather than any other we change the very constitution of being in a very specific direction' (2014, 71), materialising certain ontological possibilities rather than others, certain forms of life rather than others. In the middle of the current technoscientific transformations, Wittgenstein's maxim 'what has to be accepted, the given is – so one could say – forms of life' (1958) is, more than ever, useful for thinking the ontological consistence of a radical politics.

If a constituent politics refers, first of all, to the material capacity to affect material change, we can think, with Papadopoulos, a politics of worlding in technoscience as a capacity of crafting matter: a capacity to act that does not designate a 'substance', a 'human agency' or a 'universal wholeness', but a 'capacity to act with' (Haraway 2003) enacted from situated practices. In a politics of worlding in fact acting means always acting with. The concept of worlding comes from the work of Chris Connery and Rob Wilson (2005), where this term designates the making of social worlds that crisscross global space in variable and divergent trajectories. This notion has been created in order to put in question an abstract and universalistic reading of globalisation, valorising the plurality of tensions and routes that populated the global dimension. Their work constitutes an invitation for thinking the proliferation of differences in our contemporaneity and the notion of worlding suggests an attitude for opening our thinking and practices to other ways of being, ideas, everyday practices

and narrations. Papadopoulos extends the meaning of this term 'from society to matter'. As such: 'I want to think of worlding as an opening to material processes and practices and as a possibility for crafting – literally – common, alternative forms of life' (Papadopoulos 2018, 94). Along this perspective, a politics of worlding in technoscience is synonymous with a form of politics and a style of activism which engages directly with 'the materialisation of worlds': a politics immanent to the processes of relating and crafting that directly affects the materialisation of the forms of life that inhabit the world. What I am calling, with Papadopoulos, a politics of matter is, in fact, a way of thinking activism as a direct engagement with matter: it regards forms of human and non-human compositions, modalities of collective assembling and everyday experiences of making ecologies of living. Here politics, rather than designating an external and a sort of second temporality that impacts life and material existences from outside – as it is in representative politics and in policy – or a terrain of struggle around the big signifier of 'social power', is conceived as a constituent politics that refers directly to the conditions of possibility through which different modes of existence can live together in ecologies of living thick enough, rich enough and responsible enough for cultivating livable words and eco-social justice.

Insurgent Posthumanism

The book has two beginnings. I already mentioned the first one – the emergent material culture of posthumanism. The second beginning regards social movements, or better the political impasse of social movements in times of biofinancialisation. Following Papadopoulos, neoliberalism, the architecture of the financial system and the culture of valuation, imposes a significant impasse to strategies and tactics of social movements. Even post 2008 movements, such as the global cycle of struggles of 'Occupy' have not been capable of disarticulating the neoliberal governance. The condensation of segments of the state with specific private interests leading the current phase of neoliberal accumulation resisted to the impact of the socio-political consequences of the 2008 economic crisis. Even worst, the emersion of a global wave of regressive nationalism risks to redetermine the composition of these postliberal aggregates mixing up the ferocity of neoliberal regime with the resurgence of traditional conservative ideologies. We are in a political impasse in which the word Left is day by day an empty signifier and the capacity of movements to constitute a democratic counterpower – as it was for example in the Fordist phase – is getting weaker and weaker. This impasse demands a radical rethinking of the role of movements in eco-social transformation and what autonomy could mean in post-liberalism. From this perspective, Papadopoulos' book contributes to think the structural reasons of a crisis of democratic negotiation. At the same time, it instigates the exploration of new political intensities and fields of experimentation inside and

against the ontological configuration of politics. More than social movement is the concept that Papadopoulos offers in order to start thinking autonomy differently.

More than social movements are movements that are transforming the ontological conditions of everyday existence by experimenting alternative politics of matter. This is a form of activism that reclaims the creation of new material modes of existence through collective practices. As we have seen earlier, in this historical contingency production has a double sense: the construction of new cosmograms and ontologies and the insertion of these ontologies into scales of value. The imageries and the practices of geo-engineering exhibit Earth as a disposable world (Pellizzoni 2015) and the narrative of the Anthropocene reinforce the modern idea that the destiny of Earth is in the hands of humanity. Contemporary the financialisation of the ecological limits (Leonardi 2017) inserts the ecological value inside the financial measurement. The underlying logic of the culture of valuation is that the worth of goods, things, activities, spaces, environmental conditions and other species can be essentially translated into financial evaluation. In times in which the pervasiveness of the technoscientific apparatuses has a direct ontological impact on ecosystems and the extension of financialisation includes life and death of animals, plants and ecosystems inside his multiple logics of economical valorisation, ontology returns to politics. In these conditions the central strategy of movements consists in something less and something more than simply contesting and addressing existent institutions. Emergent socio-ecological movements are reclaiming everyday materiality by actively recomposing and rearticulating it. When ontology comes to politics autonomy is mainly about crafting new everyday political ecologies: alterontologies.

One of the key issues of the tradition of class struggle and social movements in general consists in thinking human society and nonhuman world as two different and separated spheres. Politics, consequently, pertain to the sphere of society and the principal avenue for social transformation passes through seizing the centres of social and political power. The many entanglements between politics and ontology are often erased, and the state risks to become a sort of political universal to be contested, conquered and transformed. Forms of life and modes of existence, so what makes irrelevant every essential distinction between human society and material world, are often erased from what matters as politics. I feel that the necessity to think politics in more than human worlds emerging from this book comes from a demand of life experimentation that is not anymore disposed to separate justice from everyday life, nature from culture, human from nonhuman world and action from care. Papadopoulos captures in his writing a political intensity of our times, an absolute velocity as Deleuze would say, an electric zone in which life and politics are inseparable: an insurgent posthumanism as an active tension living inside the constituent conatus of contemporary and noncontemporary movements. The notion of insurgent posthumanism has multiple descriptions

and it designates in the book three strategic escape routes. The first one is about the transition from a highly regulated relation to the material, technological and biologic realms by making a multiplicity of experimental and self-organised common worlds, a plurality of ecological spaces. The second one consists in a move from representational politics to the rehabilitation of politics as an embodied everyday practice. The third one is a move toward a post-anthropocentric history, in which history is not only made by human subjects.

Justice and More-Than-Social Movements

The volume explores the practices and the imaginaries of a series of movements: amongst others autonomy of migration, permaculture and other practices of eco-commoning, hackers and makers material culture, indigenous resistance and AIDS activism. These movements are understood and described as more than social movements, movements that starting from situated practices, are constructing other ways of inhabiting our planet. In relation to the case of AIDS activism, Papadopoulos analyses a coagulation of practices that have been going on since the start of the epidemic in 1981 in the USA. AIDS activism became possible because of the everyday alterontological practices that allowed the community in the making to sustain itself and it is thanks to the diffusion of these practices of justice that the foundation of the AIDS Coalition to Unleash Power (ACT UP) has been possible in 1987. These practices include, amongst others, the development of alternative research, the creation of alternative service provision, an extensive experimenting with one's own body and (not officially approved) drugs, the development of new forms of affection, intimacy, and reciprocity, the construction of buyers' clubs of illegally manufactured or illegally imported drugs, the invention of new sexual practices and sexual expressions, the making of new community spaces and community organizations to engage with the new challenges of the crisis.

AIDS activism in not readable without taking into account the experimentation with alternative politics of matter: social change and movements cannot be thought independently from ontological change, in fact there is no social transformation without alterontological practice. In more than social movements the everyday and the ontological is one, because justice is in the ordinary and concrete making of justice. Following Papadopoulos, the question of justice comes with the emergence of the invisibilised and the imperceptible, of those who have no place within existing normalizing political institutions. Or better justice comes when those who have no part (Rancière 1998) change the material conditions of existence in a way that cannot be overheard or simply included in existing political institutions. Papadopoulos focuses on how actors create alternative ecologies of existence that become inhabited by these silenced and absent others, by those who have been rendered residual and invisible.

This is a politics of matter not because humans are in charge of matter but because certain groups of humans and nonhumans can continue to exist only to the extent that they develop alternative entanglements with matter. For this reason, in more than social movements justice is restored materially. And at the same time without ordinary justice there are no more than social movements. This is a mundane material and generative justice. The autonomous politics of more-than-social movements are relational, ontological struggles to create alternative material articulations, autonomous spaces and communities of justice.

Beyond the Book

A key feature of insurgent posthumanism consists in disconnecting experimental practices from a highly regulated and often alienated relation to the material world. Reading the book, I was wondering about the relation between biofinancialisation and the increasing securitisation of grassroots technoscience. As Dimitris knows, I am actually conducting a participatory research on farmers and peasants' movements in Italy. One focus is on agroecology, understood simultaneously as a science, a practice, an eco-social movement and a form of life. Food and agriculture are key vectors for experimenting alternative practices of ecological transition, and the everyday practice of agroecology implies a disconnection to the standards of food production and circulation, simply because these standards are thought in relation to the infrastructures of industrial production. Not surprisingly the movement of Genuino Clandestino, a movement in which agroecology is deeply connected with the reinvention of rural forms of life, took its first steps ten years ago with a campaign of civil disobedience reclaiming the legitimacy of a series of peasant practices, such as the exchange and distribution of genuine agricultural products, mutual work aid and the reproduction and exchange of seeds, among others. Moreover, in the last years peasants and farmers movements promoted a series of proposals and public discussions around the need to build a 'peasant right' in order to obtain a political recognition of these practices. If the autonomy of migrations teaches us to see movements before capital and mobility before control, something similar could be said in relation to grassroots technoscience: everyday material justice comes before capital and experimental practice comes before securitisation. Two issues stay in the background in this very valuable and rich book and it would be worth using this and other occasions to debate them: what kind of relationship there is between biofinancialisation and securitisation and which practical tactics can open political spaces within and against the law in postliberal times.

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Alterontologies and the Art of Being One Step Ahead

Luigi Pellizzoni

Once a highly effective political intervention, identity politics was recycled in the 1990s as advertising script for Benetton or MTV. None of this makes the political struggle for women's rights, class politics, queer politics, or struggles against racism obsolete, far from it; but it does suggest that we always need to be several steps ahead of the capitalist mulching machine, reinventing these struggles, devising new language, new political strategies, new ideas, new forms of activism (Smith 2005, 891).

Experimental Practice is one of those not-so-frequent books that are as rich and dense in content as they are smooth and engaging in reading. Papadopoulos manages to integrate in a consistent, effective narrative a number of issues and perspectives, not only from STS but also from anthropology, social movements studies, political and practice theory, feminist and postcolonial thinking, putting in conversation concepts and empirical evidence drawn from a range of fields, from AIDS activism to hacker communities.

As the author makes clear from the outset, the book sits at the crossroads of two main concerns: on one side "the decentring of the human in its relations to other species, machines and the material world"; on the other "a feeling of urgency to grasp the incapacity of the extraordinary social mobilizations that took place in countries across the North Atlantic and beyond since 2006 to instil social change" (p. 1). The result is an inquiry into the connection "between the limited range of transformations that these movements have achieved and the displacement of the human and of human politics in posthuman culture" (p. 2). Key driver of reflection are the notions of ontology, understood as "the shared, durable, open material spaces – tangible and virtual – that can be inherited autonomously by communities", with special reference to those "drawn in the vortex of privatization and intense neoliberal disintegration" (p. 2), and of ontological politics, understood as "the simultaneous production of society and ontology", in the sense that "by performing ontology in a single concrete way rather than any other, we change the very constitution of being and its material organization in a specific direction" (p. 11). Ontological politics, thus, "conceives matter as a frontier" (p. 13). One can say, in this sense, that it is as old as humans' engagement with materiality in their struggle for survival and for structuring social life. Yet, Papadopoulos argues that in modernity – late modernity in particular – ontological politics takes a special relevance. Matter is "modernity's ultimate frontier" in an "epistemic territory that is constituted by its coloniality" (p. 15).

Readers familiar with the various manifestations of the "ontological turn" in the social sciences and humanities (Dolphijn and van der Tuin, 2012; Coole and Frost 2010) – STS playing a prominent role therein with authors like Bruno Latour, John Law, Annemarie Mol and Isabelle Stengers – will be easy in enrolling the book in this intellectual strand. Yet, there are significant differences in Papadopoulos's approach, compared with mainstream ones.

One is his genuine, concrete interest in emergent social movements, which "new materialist" standpoints often address in a sketchy, speculative way. As he notes, "from actor-network theory, object-oriented ontologies, neomaterialism, and neovitalism all preserve key theoretical tenets from activist materialism but drop in one way or another its activist dimension" (p. 93). On the contrary, readers familiar with literature on "prefigurative mobilizations" – broadly defined as a type of political action aimed at realizing the desired future in the here and now, through means "deemed to embody or 'mirror' the ends one strives to realise" (van de Sande 2013, 230) – will recognise in Papadopoulos's book well-known tropes, beginning with the claim that contentious politics should withdraw from traditional protest aimed at the state or other power holders, as political institutions have lost traction over global flows of capital and as the distinction between labour and life, production and reproduction, workplace and home, blurs in new arrangements of value extraction.

Resistance and opposition, so the case for prefigurative politics goes, should be based on, and can actually be found in, the doings and makings that people carry out individually and collectively all over the world. Doings and makings which, crucially, involve a close engagement with the materiality of things, a (re)consideration of the reciprocal affection and effection between humans and other-than-humans: from "alternative" forms of agriculture and energy production (community supported farming, open source seeds communities, participatory plant breeding, community energy initiatives, etc.) to self-organized healthcare, education and child-rearing, or occupation and self-management of factories, housing and other spaces.

Papadopoulos agrees with scholars who see in material engagements the distinctive trait providing prefigurative mobilizations with a major potential for change. The difference with comparable arguments, such as those developed by David Schlosberg (Schlosberg and Craven 2019) or John Meyer (2015), lies in his strong STS sensitivity to the role of technology as artefacts and processes. At the same time he is careful in avoiding the claims about the emancipatory force with which technology or materiality in general would be provided – if and when freed from the cage of Cartesian naturalism and humanist substantialism – that one meets in much new materialist literature (see e.g. Bennett 2010; Braidotti 2013). Namely, the postcolonial inflection of Papadopoulos's take on post-humanism, with the awareness of historicity and positionality that such inflection entails, makes him wary of an ontological monism committed to celebrating the liberating character of the acknowledgment of the (alleged) full contingency and fluidity of reality; a monism which, in his eyes, becomes a non-humanist version of traditional universalism, and which results in a "weak materialism" (p. 81), in the sense of being mortgaged by an epistemic, rather than practical, embodied, relation with the world. Making, Papadopoulos contends, "cannot be approached as an epistemological issue; it is a practical one. Making is a material movement; it is about ontological practice rather than about an abstract representation of a practice of material engagement. And as such this movement is embedded in other previously existing ontologies. Each of these ontologies involves different environments, materialities, digitalities, groups of people, and more-than-human actors. Marisol de la Cadena, Mario Blaser, Arturo Escobar, Walter Mignolo, and others refer to this multi-ontological organization of the world as a pluriverse" (p.175).

I am fully in tune with this statement and with the book's standpoint in general. What I say below, therefore, is not so much a critique aimed at pointing out weaknesses, as an indication of issues which, to my eyes and according to Papadopoulos's own argument, are of major relevance in the case for a new, effective, political activism, and which therefore call to further elaboration anyone committed to this case.

I put in the opening of this commentary an excerpt from the much missed Marxist geographer Neil Smith. Smith warns social critics – as

scholars and/or activists – to be careful about how they move on. They should not be like Walter Benjamin's Angel of history, whose gaze is turned backwards. Namely, they should not linger with critical categories forged on and effective against certain power relations and conditions of domination, failing to realize that such relations and conditions are of lessening relevance, and that power is applying their own categories to its own purposes. This warning is of course not only Smith's own. Boltanski and Chiapello (2005) and Autonomist Marxists (e.g. Virno 1996) have raised similar remarks concerning post-Fordist capitalism's capture of social movement and intellectual "libertarian" critique of Fordism and embedded liberalism, refashioned in terms of flexibility, lifelong learning and creative self-engagement (= job insecurity). A comparable sort of warning, concerning the more recent evolution of neoliberal rule, has recently gained momentum in the debate over "post-truth" and the alleged responsibilities of STS for its rise (see e.g. the debate in the 2017 issues of *Social Studies of Science*; see also Fuller 2018), the point being this time how the lesson of science deconstruction has been learned and is increasingly applied by "right-wing postmodernism" (McIntyre 2018) to undermine unwelcome scientific evidence (see e.g. Michaels 2006; Oreskes and Conway 2011). The issue of the perverse effects of science deconstruction had been famously raised by Latour (2004a) some years earlier, though, as usual with him, with no reference to capitalism or neoliberalism. I also have tried to work out a reflection over the limits of a scholarly and activist, theoretical and embodied, critique that dwells in the same problematization (to borrow Foucault's term: namely, the same ontology, the same sense-making of reality) of its target (Pellizzoni 2016). On this basis, I think that among the topics deserving attention in order to get critique "several steps" – or at least one – ahead of its subject matter there are the following: the issue of *scale*; the issue of *representation*; the issue of *experimentation*. I choose these because they are both cornerstones of Papadopoulos's argument and hot spots in the never-ending chase between power and its opponents; between subjection and emancipation.

Papadopoulos agrees with Anna Tsing that scale is a major issue for both scholarly analysis and oppositional practice. Indeed, a frequent objection against prefigurative mobilizations concerns their inability to scale up to a level comparable to the forces they are tackling. By no means new (anarchist predilection for direct action, self-organization, mutual aid and in general for behaving as if the state and other institutionalised powers did not exist anymore, has been traditionally challenged on this basis), the limited efficacy of prefigurative politics – up to becoming instrumental to the continuation of the rule from which it seeks to disentangle, by offering goods and services that the market and the state are unable or unwilling to provide (Bosi and Zamponi 2019) – is a typical workhorse of critics (see e.g. Mouffe 2013).

Papadopoulos acknowledges this objection, asking "how can alterontologies contribute to a decolonial politics of matter" (p. 22); how can

major infrastructural changes or large technoscientific projects be challenged by a politics of crafting from below and on the ground. His reply is again in tune with Tsing, namely, with her call for paying attention to the ideologies of scale as integral and crucial to capitalist projects, understood as "relatively coherent bundles of ideas and practices as realized in particular times and places" (Tsing 2000, 347). So, crafting alterontologies is also, and crucially, about scale-making, and more precisely about "rescaling the geographies of technoscience in ways that matter" (Papadapoulos, p. 22). Rescaling (mainly in terms of downscaling) is actually a core point of degrowth theory and activism, and a distinctive trait of new materialist mobilizations in general. Additionally, various scholars warn about the declining returns on energy and research investment, the former being related to the growing difficulty in extracting resources, the latter to a R&D scenario characterized by growing organizational complexity to get marginal gains in innovation (Fizaine and Court 2016; Tainter 2006). So, it may well be that ever-expanding technoscientific infrastructures are bound to collapse under their own weight and that surviving capacities will be downsized by necessity. This, however, confirms that scale is not just a matter of will.

Precisely because, as Papadopoulos claims, matter is not infinitely manipulable and plastic, getting certain outcomes by downscaled means may result impossible. True, to some extent scale-making and goal-seeking are implied in one another. Alterontological experiments do not pursue the same goals of the ruling interests. Participatory plant breeding or community energy initiatives have different aims to those of Big Pharma or oil companies. Additionally, one may argue that large-scale technologies and infrastructures address issues which they themselves have created. For example, by reversing the growing extension and intensification of farming one may expect that pandemics will be less likely to develop. Yet, can this lead to giving up research on vaccines or stockpiling medical equipment such as ventilators? Can this lead to saying goodbye to anything requiring complex organizations or to complex, high-tech devices? Should one just come to accept, in one's own redefinition of goals, that a shorter life than the one assured by this means for some decades in affluent countries (but increasingly also elsewhere) is in the order of the day? My feeling, in brief, is that the issue of scale has till now only been scratched, and that the idea of a frontal opposition between the ontological politics of global capitalism, with its big technoscientific programs and worldwide infrastructures, and downscaled, off the ground alterontologies is too schematic; and this not only for the proverbial risk of throwing the baby out with the bathwater, but because the very notion of alterontology, the way it is conceived and performed, is in itself an effect of globalization, being conceivable only against the backdrop of the latter's fuzzy universalism.

A crucial performance of alterontologies is, anyway, its capacity of resisting the politics of inclusion in the global capitalist system. Papadopou-

los – in my view rightly – emphasises that such politics offers a poisoned fruit, as its goal is not recognition and respect but control of alterity through its reduction to manageable formats. Inclusion is crucial to the universalising project of capitalist production, understood as both "the construction of new ontologies and the insertion of these ontologies into scales of value" (p. 28); a project that reaches a full-fledged expression in the financialization of everyday life – "biofinancialization" is the author's appropriate expression. Inclusion entails the provision of rights yet, he notes, "only through representation are rights possible" (p. 55), as rights are assigned to subjects defined according to given criteria. To be acknowledged, in other words, you need to fit a certain description, conform to a certain framework. More to the point, to be included you have to accept to be valued as capital. So, representation appears crucial to the universalizing design of biofinancialization. "When matter becomes a frontier, the attempt is to make it productive… [and] compatible with the existing mode of production" (p. 15); with the ruling accumulation regime. Alterontologies, in this sense, are those socio-material assemblages which resist representation, remaining irrepresentable, irreducible to manageable formats.

In this way Papadopoulos parts company with the politics of representation of the non-human that is key not only to capitalist politics but also to environmental theory and activism and new materialist thinking, having found in Latour the most accomplished and well-known STS advocate. On one hand, representing "nature's interests" has always been a weak point in the environmentalist case, for the shaky basis of any (self-)appointment – usually grounded on scientific expertise, less frequently on moral authority, aesthetic sensitivity, contextual acquaintance, and so on – as spokespersons of entities which cannot give their authorisation. On the other hand, Latour's (2004b) account of a more-than-human parliament composed of two powers of representation – of taking into account and of ordering and stabilizing – has met with a number of criticisms, including about his explicitly Hobbesian understanding of representation, as "a matter of assembling disparate individuals into a unified whole with a single will" (Brown 2017, 39). As already noted, universalising thrusts are a main concern for Papadopoulos, as quintessentially dominative. In his view, any politics of inclusion of matter, as its frontier moves on, turns out at best in an exercise in weak materialism, a failed attempt to grasp and describe alterity, to subsume the ontic into the epistemic; at worst in a neutralisation of any potential for change. Against this, Papadopoulos takes sides with the non-representative turn in political theory and the social sciences. "Post-foundational" (Marchart 2007) political and social theory, committed to questioning metaphysical figures of totality, universality, ground, essence, community, nature, has found a cornerstone in non-representative ontologies building on affect, emotion, desire, care, and the immediacy of embodied practices (Connolly 2002; Gibson-Graham 2006; Thrift 2007; Alaimo and Hekman 2008; Puig de la

Bellacasa 2017). Concerns, however, have been raised about the implications of withdrawing from an account of democracy as based on exchange of reasons (Barnett 2008). Indeed, how to give room to both rational and affective aspects of political life remains an open question. Yet, my point here is another: namely, that affect, emotion, desire and care not only are key to alterontologies but are the bread and butter of neoliberal governmentality (Rose 2007) and populism (in this case combined with tropes of identity, belonging and authenticity: see e.g. Caiani and Padoan 2020).

So, a non-representational politics is hardly per se provided with emancipatory import. By the same token, Adorno warns that one is to resist the lure of immediacy, of a "shortcut to practical action" (Adorno 2001, 2) which does without conceptual mediations. Against Deleuze and Guattari's (1987) claim that actual pluralism resides only in an accomplished monism, Adorno's monism is dialectical, in the sense that thought and thing, theory and practice, are enmeshed from the outset, reciprocally necessary and never reducible to one another, the emancipatory opening lying not in their blurring and coincidence (which for him correspond to identity-thinking, hence to domination), but precisely in their friction, the remainder of any attempt to match them. In accord with Adorno I think that a "weak materialism" is avoided only by acknowledging such friction. How to build on this is, again, an open question. However, for example, Mark Brown's notion of "representation by fiction" – the type of representation legal systems admit for organizations, children or deeply impaired people – may capture to some extent the spirit of Adorno's dialectical monism, as any such representation can never claim to express a full delegation or a consistent reporting, being always open to contestation "as an ongoing process in which citizen witnesses, as the audience of representation, imaginatively construct a relationship between representatives and those they represent" (Brown 2017, 44), including nonhumans such as animals, species, habitats, or ecosystems.

As anticipated, my last point concerns experimentation. Beginning with the title and throughout the book Papadopoulos stresses that alterontologies consist of experimental practices, as the only viable reply to a power that has increasingly taken the shape of a technocratic (attempt at) control of the entire reality, from individual everyday life to worldwide social and more-than-social processes. I subscribe to this standpoint but I think it important to acknowledge and address the ambivalence of experimental politics. I propose here two considerations. First, as plenty of research has documented, experimentalism is central to neoliberal governmentality. Since the early 1980s, building on the assumption that there are fundamental limits to prediction and planning faced with intricate social, technical, and ecological dynamics and interactions (an assumption supported by emergent theories of complexity, from chemistry to the life and computing sciences, and by an influential managerial literature), the ruling vision of uncertainty, insecurity, volatility, disorder and non-predictive decision-making has turned upside down, from limit to pur-

poseful action to enhancing condition of indeterminacy. Hence a growing celebration of foresight, flexibility, adaptability, resilience, "anti-fragility" (Taleb 2012), preparedness to surprise, and so on (see O'Malley, 2010; Walker and Cooper 2011; Pellizzoni 2020a). In the early 1970s Alvin Weinberg (1972) talked of "trans-science" to convey the idea of a science increasingly confronted with "unbounded" issues, engaged in experiments outside the lab, as in the case of the management of radioactive waste. Twenty years later, Krohn and Weyer (1994) comparably talked of "real life experiments", simultaneously physical and social and with outcomes often barely imaginable, while Funtowicz and Ravetz (1993) talked of "post-normal science" referring to the ever-more frequent situations where facts are uncertain, values in dispute, stakes high and decisions urgent. All these accounts depicted indeterminacy as problematic. Yet, for example, geoengineering (in both its two main variants: carbon capture and storage and solar radiation management) is today increasingly advocated as a solution to global warming, or at least as a way to buy time, which testifies to a burgeoning rationale whereby it is sound to let complexity unfold, even to "incite" it by adding further turbulence to unpredictable dynamics, the strategy being one of surfing the crest of the wave, reacting and adjusting on the spot to its swerves (Pellizzoni 2020a). Similarly, the way the insurgence or resurgence of pandemics is addressed, in academic and governmental quarters as well as in the media, is by taking for granted that this is bound to intensify, the only sensible option being to increase preparedness rather than trying to address its root causes (Lakoff 2017; Pellizzoni 2020b).

This leads to my second consideration about experimentalism. In the social sciences and humanities a growing concern can be registered for geological processes, understood as including not only climate but also biodiversity shifts and viral and bacterial dynamics, testifying to the prominence of an "inhuman" nature (Clark 2011), in the sense of a materiality overarching and indifferent to human issues. The change in focus from biopower to geopower (Grosz 2011) or "geological politics" (Clark and Yusoff 2017) has been accompanied by a marked change in attitude. Consider once more Latour. Twenty years after *Politics of Nature*, *Down to Earth* shows how he has given up any call to diplomacy and interest composition with the other-than-human world. The "intrusion of Gaia" in human affairs (Latour 2017; Stengers 2017) is described in the same terms once attributed to sovereign power and later to market forces – supreme, indifferent, unwarranted, unaccountable. Gaia represents "a form of sovereignty, […], a power that dominates the heads of state" (Latour 2018, 84). Faced with it, the only sensible way to go is – guess what – applying the neoliberal recipe: surfing the unpredictable, cultivating preparedness, resilience, flexibility and "ongoing creative experimentation" (Clark and Yusoff 2017, 18). So, in Latour's latest narrative, the unifying inclusiveness of a more-than-human diplomacy and interest composition is replaced by a differently but no less dominative approach: the

acknowledged necessity of bowing to an overarching entity, under the assumption that "there is no other politics than that of humans and to their own benefit", and there is no possibility of living "in harmony with so called 'natural agents'" (2018, 86-87). By any evidence we are here at the opposite of the case for the pluriverse as made by Papadopoulos and many others (see e.g. Blaser and de la Cadena 2018; Kothari et al. 2019).

In short, experimental politics, like scale-(re)making and representation, is a double-edged issue, in need of careful analysis and discrimination. Papadopoulos masterfully highlights its relevance for conceiving and pursuing possibilities of change grounded in the pluriversal practices of more-than-social movements. The anything but easy task for anyone who cares about such possibilities is to disentangle emancipatory, progressive ways of experimenting from dominative and reactionary ones.

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Have We ever Been Posthuman?

Roberta Raffaetà

'Experimental Practice' is not simply the intriguing title of this book: the book is in itself an experimental practice. Papadopoulos successfully connects through the lens of social movements a number of topics that are seemingly unrelated: health governance, transnational journeys of migrants and refugees, extractive practices of finance, and communities of craft and design. The book is an example of the generative potential of

working at the interfaces between sub-disciplines and themes. While it remains productive to conduct in-depth research within one specific subfield, this book is an example of how working at the interfaces makes it easier to see the emergence of new socio-political phenomena.

This book therefore is not *about* science, even if it has a strong STS footprint. Technoscience is not its focus but "the stage of which its arguments are played out" (p. 1). This, according to the Author, is more a necessity than a choice, given that recent times are marked by a "continuous folding of science, technology, and the everyday into each other". Papadopoulos portrays technoscience as part of the everyday, something inescapable, something to work both within and against, thus contributing to the deprovincialization of STS. Technoscience is described not only as a more than human endeavour but also as more than scientific, giving emphasis to its entanglements with the public sector, the private sphere and the commons. It is clear, from reading this book, that neat and stark dichotomies such as the public/private sphere, humans/non-humans, emancipation/control, freedom/exploitation are not tenable anymore and that there is a need for a more nuanced understanding of what is happening across these extremes. The proposed contribution of the book is to bring specificity to these kinds of interactions and analyse how, in their unfolding, a new politics and new ontologies may emerge.

At the convergence between novel ontologies and politics Papadopoulos posits "alterontologies" and "compositional politics" that happen when "actors emerge in the political scene by changing the very constitution of being". These emerge by acting both against and within institutional powers, forging a relationship that is neither of mimesis nor of conflict. Compositional politics is needed, according to the Author, in order to be able to escape the "biofinanzialization" of life. Papadopoulos in Ch. 2 analyses the post-industrial assetization of the whole planet, made possible by the translation of everything into one logic of financial value. In this framework, every aspect of life – from human non-work time to human and nonhuman reproduction and matter – has become a financial asset. This process has been made possible by separating the product of work from the process of work and treating the embodied and emplaced dimension of value creation as external to social and material dimensions. Papadopoulos describes finance not as a discrete cultural phenomenon among many others, but as culture, a culture that has colonized all the other spheres of existence, and from which is therefore impossible to escape.

Starting from the recognition of the impossibility to escape the biofinanzialization of life – what seems to me a Foucaldian framework of control and exploitation brought to its extremes - the Author proposes to let go of impossible dreams of independence and autonomy. Rather, to search emancipation through the creative recombination and composition of matter. The subsequent chapters give examples of how this and theoretically explore compositional politics.

Ch. 3 narrates of a "World 2" that exists beyond -and overlaps with traditional politics and social movements. This other world is made by migration activists and migration movements that seek to realize their aspirations of transnational paths and life by ontologically (re)configuring their ways of being. Papadopoulos puts forward his best effort to illustrate how this can be possible despite and along all the legislative, political and social obstacles. Ch. 4 and Ch. 5 constitute the theoretical core of the book, those in which the Author shares with his readers his intellectual journey.

Ch. 4 is an historical-political narration of matter, proceeding from the rereading of the first Marx to Deleuze e Guattari, to finally advance a materialism *cum* activism. This position is developed in Ch. 5 by retracing first insurgent forms of posthumanism in communities of individuals escaping institutional power. But exactly in this historical emergence, Papadopoulos identifies the very beginning of the mutual relationship of both freedom and exploitation, emancipation and control. A dialectic that lays the ground for the current one between the individual and the State. The Author indeed shows how the condition of individual freedom enjoyed by those early communities offered energy to the nascent industrial state. The only antidotes to avoid remaining captured in the toxic aspects of this dialectic is, for the Author, pursuing – as in those early communities - an ethos of practice. The other is to leave behind universalizing and anthropocentric aspirations of humanism. The Authro's warns, however, that this approach should not take for granted the kinds of politics that grounds a postanthropocentric posture (see, for example Benadusi et al. 2016; Blaser & de la Cadena 2017). He rejects a simple "ecological egalitarianism that considers the value of all nonhuman beings as equal" (Puig de la Bellacasa in note 69, 235). I appreciate this disconnection from those uses of posthumanism more as a fashionable mode than a theoretical program toward posthumanist politics. Humans' entanglements with nonhumans are not free from conflicts and ambiguities, as any kind of relationality, as recently forcefully emphasized by Marylin Strathern (2014, 2020) to counter the mounting fetishization of the concept of 'relation' as a an inherently good thing. Relationality is not something positive by itself but a particular artefact of Euro-North-American knowledge-making which also implies cuts and breaks and cannot stand outside of analysis or critique. Papadopoulos is -I think appropriately - aware of this, concluding the chapter by affirming that "The aim is to politicize posthumanism and simultaneously to posthumanize politics by decolonizing both of them." (p. 114).

Ch. 6 and 7 explore how a compositional politics may realize in present times and which are the tensions and ambiguities, taking brain matter and AIDS activism as examples. Ch. 6 illustrates how neuroplasticity opens new horizons for emancipation but also for control, a plasticity that derives from a common brain while being fully privatized at the same time. Ch. 7 challenges the conventional ways in which politics has been

conceived in science and technology studies by comparing the politics sustaining AIDS activism. This one is a situated and compositional politics.

Ch.8 ends the volume by pulling the strings of the various insights through a reflection about ontology and technoscience. First of all, according to the Author, ontology is a movement rather than a structure. This move mitigates the excesses and determinism of certain materialist thinking (for this critique see Abrahamsson et al. 2015; Paxson & Helmreich 2014). This movement is described by the Author as deploying in a circular (indigenous) temporality rather than in a linear one, and this helps decolonize "the Western domination of our imaginaries of what will come". Within this multiplicity, however, Papadopoulos portrays a world made of multiple but at the same time connected and interdependent ontologies because all "they belong to the same shared earthly world". With this, I think, he saves us from the centrifugal and desegregating tendencies of certain extreme threads within the ontological turn (for some critiques see Heywood 2012; Laidlaw & Heywood 2013).

Secondly, in this multiple, but yet connected world, technoscience remains for Papadopoulos a tool of advocacy and emancipation. Against the conventionality of an asphyxiated and asphyxiating social sciences' critique of technoscience (see also Seaver 2017, 2018), he emphasizes how technoscience is indeed not only in the hands of projects of domination and control. According to the Author, this is only "the peak of an heterogenous movement" that uses technoscience creatively in ways that can emancipate them because the "possibility for uncomputability is always inherent in computation itself" (p. 179). Therefore, a compositional politics of the present is, for Papadopoulos, always and already digital and material at the same time. The Author takes social movements of hackers and crafters as his references, movements that attempt at "changing the conditions of knowledge production by changing the ontological fabric of life" (p. 206). Drawing from his participant observation in those movements, the Author delineates a possible ethics informing compositional politics. This is made of commensality, rather than exchange and relations, a concept that I found saves us from a superficial understanding of relationality as something valuable in itself, despite its grounding politics. Commensality also emphasizes the fact that invention is always something mediated and anticipated in a human and more-than-human collective, against conventional laws and understandings of intellectual property as bound to human individuals. Yet, commensality is not the same as indifference, there is an affective engagement in which 'care' remains the "ethopoietical compass" (p. 201).

As is clear from my comments above, I found this book particularly interesting and full of profound insights. Yet I am happy to share some further comments in the hope they may help to enhance engagements with matters with which we care. I will bring attention to three interrelated themes: practice, theory and the role of institutional power.

First, the book's title (Experimental Practice) leads attention toward the concept of 'practice'. The book indeed proposes an "ethos of practice", with practice itself as the means toward emancipation and the composition of alternative ontologies and politics. The idea is that practice is what may change things, much more than words can do. The prominence given to practice somehow strikes, I think, with the limited space given to its narration. In the book, 'practice' is dealt with mainly as a conceptual construct, but it is not particularly narrated as situated events, happenings, encounters, strategies, profiles, biographies, spatial-historical details and the likes. Doing so would have had enriched the book, I think. I would have liked to see more ethnography, more 'thick description' of how alterontologies may become politics.

And this is not to invoke ethnography for the sake of ethnography. The definition of ethnography is an open question, especially in recent years in which there is an intense debated about what ethnography is, is not or should be (e.g., Ingold 2017). I would like to leave these anxieties of purity behind for now, allowing space for the most varied and creative appropriations of what ethnography can be. I am also aware that every book has its own character and in the present case it seems to me that the impetus for the writing have originated more in the will to share some reflections sparked by long-term ethnographic experience in different fields, rather than from reconstructing one single history in depth. An example of the latter can be found, for example, in the book 'War on people' by anthropologist Jarret Zigon (2019). Zigon advances reflections similar to the one dealt with in this book but that work displays more ethnographic texture, focusing on one single case study, that of AIDS social movements. Papadopoulos, however, is immediately very clear about his approach, emphasizing that his is a "deeply speculative undertaking" and that one of the beginnings for his book is "an affect rather than a phenomenon" (p. 2.). This is all fine, because the Author's capacity to see within but also across and beyond specific case studies is one of the positive aspects of the book.

Yet, my plea for more ethnography is inspired precisely by the capacity of the Author to convince me that practices may change things and have a political role. In this light, to call for ethnography is to call for politics. Ethnography before being a genre has, for me, a political commitment to play in showing how alterontologies may compose themselves and change things, which are the constraints, the timelines, the opportunities. To know this would amplify other communities' awareness of the opportunities for alterontologies to exist and how to make them emerge within the particularities of their own context. The recognition of the emergence of new political actors who are able (in synergy with other humans and nonhumans) to change the very constitution of the contexts in which they live is so important that we all would benefit from a more fine-grained description.

My desire for more ethnography stems from a desire for more details

about the multiplicity of daily practices and interactions that enable a social actor "to emerge" within and against a *status quo.* These details would be useful because it is not so simple nor automatic to apply the ideas outlined in this volume. It is not easy to reverse the biofinanzialization of life, this gigantic hegemonic machine, by displacing it. It is not banal to compose a form of life able to constitute itself before recognition, "a form of life that cannot be bypassed – not because it defines in a deterministic fashion the outcome of actions, but because it creates new ontologies that allow specific actors to become actors and to intervene and interrupt or alter the constituted order of a region of objectivity." (p. 154). The world is full of "dispersed, everyday, imperceptible politics" (p. 157) but, from my experience as an anthropologist, many of them cannot arrive to occupy a place in history or change any constituted order or region of objectivity. They remain dispersed and imperceptible because cannot make of their diversity "a diversity that makes a difference" (Bateson 1972, p.453). In other words, a difference that is accepted, visible and generative for many others. The issue, to me, is not just in being 'alter' but of being able to make this alterity something ontological not only within small and marginal worlds but to enlarge this marginality to broader worlds.

Papadopoulos gives us hope about the fact that emancipation can happen and in his book he reviews some examples but it remains unclear to me how this transformation can happen for others, and I long for instructive details of how this happens on the everyday, micro interactions within the resistances and cracks of institutional powers. I write in my position as anthropologist, who works together with communities and collectives to whom I want to bring something useful to make our shared world a better place, helping in fostering the link between a 'potential' and a 'possible' (Zigon, 2019) world. Therefore, I am not claiming details for the sake of details, nor I am attempting at policing a form of writing (ethnography), requesting adherence to an imagined disciplinary canon. Instead, my plea for more ethnography has been stimulated by the generous and thought-provoking content of the book, a plenitude that requests for more of it to became real for the highest number of communities that are trying to compose other worlds. I am aware that a receipt does not exist, and I am not calling for scalable solutions in neoliberal terms (for alternative meaning of scalability see Clark 2012; Olson 2018; Raffaetà 2020, p. 238-241), but telling detailed stories may help. I think the problem does lies not in scalability itself but in the capacity to allow different scales to enter into dialogue without eliminating the indeterminacies and diversity that happen at encounter of different scales (for this concern see Tsing 2012, 2015). I think ethnography can help because its multiscale sensibility enables people to "give meaning" and "inhabit" the "interfaces among scales" (Bougleux 2015).

The second point I would like to raise is specular to the first. The space given in the book to theoretical speculation strikes with how little

theory is valued as a conceptual category and a means for emancipation. The Author gives primacy to practice and derives from it an ethos that he delineates as open-ended because practice "by definition is undecidable". But how then are decisions taken? Which ethics grounds an ethos of practice? Papadopoulos tells us that the ethos of practice is oriented by "maintaining a commitment to justice that addresses radical asymmetries" and by a culture of care (Puig de la Bellacasa 2011). I agree that care and ethics may be open-ended and are affective, embodied capacities. However, care and the capacity to recognize asymmetries are not something innate (even if embodied) or automatic but come "from a reflexivity that has to be trained", as observed by Laura Centemeri, one of the discussants of the book during the POE[1] symposia held on November 2020 (see also Centemeri, 2019). Care is linked to the "arts of noticing" (Tsing 2017, p.37) and this implies a pedagogy, an education to attention. Practice, alone, does not offer an entry point to understand reality: "praxis tout seul explique pas, est pas transparente" (Descola 2011, p. 73). The same practice can be observed and perceived in very different ways, depending from the positionality of the observer (see, for example the debate in anthropology between Sahlins e Obeyesekere in Borofsky, 1997).

With this, I certainly do not wish to reintroduce a dichotomy or a hierarchy between theory and practice, yet I am doubtful that obscuring the value of critical reflection in favour of practice may be generative. Hannah Arendt has clearly stated the importance of integrating *vita contemplativa* and *vita activa* because is not possible to know in passivity but only by experimenting (Arendt, 1998, 290). But when *vita activa* assimilates *vita contemplativa* in itself, it seems to me that the ethic-political dimension of practice remains silent and implicit. In this silence, practice as a means toward ethics risks being either something for a cultural elite or something ambiguous and prone to be recaptured within different projects, that may have very different political visions. For example, the crafters' motto 'Start even if you do not know how' (p. 185), taken by the Author as a model, expresses the inventive and emancipatory framework of crafters but resounds the too familiar Nike's 'Just do it'.

It is not always the case that practices are careful. Too much emphasis on 'practice' as epistemology may also, inadvertently, be in line with a certain productionist mode that values life and experience for what it can produce, for its tangible outcomes. What critical reflection can offer, I think, is qualitatively different to simple production, yet not without ontological consequences. In the anxiety to emancipate from the nature/culture dualism, we risk that shared representations, interpretations, common sense[2] and values get sacrificed. But these configure and are part

[1] Politics, Ontology, Ecology is the name of a group of Italian scholars with different disciplinary background discussing at the intersection between the three themes, see http://www.poeweb.eu/

[2] For a heartfelt defence of 'common sense' as culture see Clifford Geertz (1975)

of affective dispositions, attitudes and affordances. Critical reflection is not a task opposed to practice, as ethnography – to link with my previous comment – is not a simple description but a theoretical practice (Raffaetà 2020b) or a "theoretically oriented practice" (Matera & Biscaldi 2020). Critical reflection is an embodied and affective practice that enables us "to think what we are doing" (Arendt, 1998) and this is especially vital in a technoscientific era, if we wish to keep our ability of being "acting men" (*sic*) and not simply "performing robots" (Arendt, 1998, 178-179). I see activism as the outcome of a theoretical practice, more than its premise. At times, reading the book, I wondered which was the Author's approach.

Finally, I pose a third comment about the book's main hypothesis. Papadopoulos in the opening of the book writes that "there is a connection between the limited range of transformations that these movements [*traditional social movements*] have achieved and the displacement of the human and of human politics in posthuman culture" (p.2) because "In posthuman conditions, traditional politics and the corresponding social movements can support us in this endeavour [*compositional politics*] only to a limited extent." (p.10). But the impression that is left to the reader – at least to me – is the classical problem of the chicken or the egg: what came first? The emergence of political actors seems to be possible because a certain human institutional power has supported that emergence (see also Dei 2017; Murphy 2017; Povinelli 2016) in a manner that exceeds "a limited extent". This may have happened intentionally (within its scope) or not (in the cracks of the system). For example, the migration activists and migration movements described in Ch. 3 can compose their alterontologies and 'emerge' as political actors in Calais also because – as explained by the Author - the State accepts migration as a temporal governance of labour. The Author seems to acknowledge at times the interdependencies and ambiguous tension with institutional powers (and this is one of the merits of the book), while at times it looks to me that these problematics are underestimated. Probably this derives from the Author's connection with the posthumanist debate. To creatively experiment ways of composing new ontological configurations with nonhumans (e.g., Hayward 2010; Hustak & Meyers 2012; Meyers 2017) may been healthy, enlightening and generative. But to translate these alternative ways of social-political coordination in the politics of social movements seems to me a too brave step, at least for the time being. Anyway, some bravery is needed to bring change; more ethnographic details would help to realize how this may be possible.

To assign an essentially 'alter', posthuman ontological dimension to some social actors, different to that of traditional politics that let them emerge, may risk being a gesture with more harmful than emancipating consequences, such as constraining the potential for change and dialogue, uncritically reproducing the system, or allowing people to be caught prey of the capture in other frameworks. For example, in the book, communi-

ty technoscience is often opposed to institutional technoscience. In my own experience (Raffaetà 2020a), institutional technoscience (if analysed ethnographically) may be as much as creative, dissenting, iconoclastic and activist as community technoscience. That's why I emphasize the importance of not considering human institutional powers as being at the margins of a posthuman compositional politics: if we'll be attentive listeners and observers, and critical allies, the potential for collective ontological reconfiguring will be greatly enhanced.

To conclude, I have greatly appreciated the political, ethical and activist tone of the book, able to maintain - at the same time - the capacity to not fell prey of many of the shortcomings that are very common in the current posthuman/ontological debate. And I have also appreciated the associated posthuman aspiration. The title of my contribution is of course provocative: yes, we have been, and we are, posthuman because our being human is based on more than human worlds. I feel totally aligned and I am grateful to generous attempts, as that of Papadopoulos, that try to advance ways of being in the world that are caring for other humans and nonhumans, and I share the Author's genuine and profound desire to help compose more just ontologies. At the same time, I think that to underestimate how much human we still are - how much we need to share stories, reflect about them and about our constitutive entanglement with human institutional powers - at times may risk being not careful enough.

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* * *

Rewilding Practice

Dimitris Papadopoulos

Practice is one of these concepts that has endured the regular change of theoretical fashions in the history of Western social thought primarily because of its mellow nature, its pragmatic disposition and its remarkable adaptability. Practice complicates the dichotomy between structuralist views of social organisation and micro-social views of individual action. Many of these complications have been nurtured by the work of people such as—not an exhaustive list, of course, and in no particular order—Dorothy Smith, Michel de Certeau, Sherry Ortner, Pierre Bourdieu, Tim Ingold, Elizabeth Shove, Anthony Giddens, Sylvia Scribner, Theodore Schatzki, Ian Hacking, Ludwig Wittgenstein, Marilyn Strathern, Martin Heidegger, Jean Lave, Michel Foucault, Michel Polanyi and many others. Practice has been also a catalyst in the make-up of my intentional academic community, Science and Technology Studies (STS), where *Experimental Practice* is primarily and unorthodoxly located: see for example the works of Karin Knorr Cetina, Isabelle Stengers, Susan Leigh Star, Thomas Kuhn, Andrew Pickering, Joseph Rouse, Sharon Traweek, Sal Restivo, Karen Barad, Harry Collins, Bruno Latour, Michel Callon, Margaret Lock, Michel Lynch—practice travels and transcends, connects and differentiates.

But practice complicates another established binarism, this of the human and the nonhuman. Practice is embodied, material, a-subjective, it is often indifferent, engaging, uneventful, it is always present, and it is often imperceptible. Practice is an ordinary concept. And this is important for me. The accompanying anecdote is that *Experimental Practice*'s original work in progress title was *Experimental Politics*. While writing the book, especially the later parts, politics seemed a bit too heavy for depicting all these extraordinary everyday …well *practices* of so many humans and nonhumans that populate the baroque, polyphonic, eclectic, and, admittedly, not-so-ethnographic ethnographies of the book. I felt that that politics was a reductive word for what *Experimental Practice* was trying to

do: there is a lot of politics in practice, but practice is not only about politics.

Practice or Politics?

I am grateful to Andrea Ghelfi, Luigi Pellizzoni, and Roberta Raffaetà for their generous and thought-provoking comments on *Experimental Practice*. They raise many important questions, and I can only address a few within the limited space of this short essay. All three of them in some way or another touch upon the relation between practice and politics: Why is practice political? Can practice, especially experimental practice, offer alternatives? And to what extent can practice give birth to some politics of empowerment? What drives practice? As much as practice is crucial for the project of the book, my aim nonetheless is not to defend the concept as such. There is always so much that you can project onto a concept. My aim is not to defend (or challenge) concepts but to interrogate ways of life that are associated or even entangled with these concepts. And, precisely, practice is connected with ways of life that allow me to explore possible escape routes from the current spell of environmental doom and "capitalocentric" gloom, and the sense that "nothing *really* changes."

So, how much practice do we need to change things? If there would be millions of people experimenting with practices such as those described in *Experimental Practice* and in so many other books that laid the foundations for understanding alternative forms of material social transformation and social movements, the world would look very different now. Pellizzoni raises this critical issue and points towards possible limitations of practice: what if all this wealth of practices never coalesces to change the world? Even worse, what if the concept of practice is already appropriated in the value production systems of contemporary Global North "I-do-not-know-how-to-call-them" societies (and I do not know because they are not postmodern and they are not late modern and neoliberal and they are not postindustrial and postnational and it is not platform or cognitive or affective capitalism and they are not financialised and they are not postliberal …phew societies, but they, of course, blend many aspects that constitute these descriptors)? So, what if practice is already co-opted and captured? *Experimental Practice* describes many instances that would support this argument: creativity, which is the engine of many different practices in contemporary Global North societies, has also become the driving force of current forms of production in "I-do-not-know-how-to-call-them" societies. Creativity, which in the 1960s and 1970s looked like a force of liberation against the oppressive nature of labour, has become today the dominant form of subjectivation in Global North societies. For example, situationists, and in particular Raoul Vaneigem, have promoted an emancipatory vision of creativity. They argued that creativity—and not labour—is the driving force of human his-

tory in order to find that we are today under the spell of the imperative to be creative, to innovate and invent. Instead of being the *only* force that can "rid us of work", creativity has become the heart of contemporary value creation in the Global North.

However, the conclusion that *Experimental Practice* draws from the fact that practice drives value creation, and even becomes an asset in itself, is not that practice is co-opted but rather that practice implicates. Practice implicates us because it is never just one thing but transversally positioned across power divides, social asymmetries, political injustices, ecological imbalances, and material conflicts. And it is not only practice that implicates us but even more so experimental practice. There is a lot of important scholarship, including the work of Pellizzoni, that has shown the entanglement not only of practice but also of experimentalism with neoliberal governmentality through capitalising on uncertainty, insecurity, volatility by compelling us to become inventive and experimental. However, as much as experimental practice is the engine of the productive regime of contemporary Global North societies, it is also the source of an excess that cannot be easily channelled and organised within the pressures of current forms of value creation.

What *Experimental Practice* argues for is that practice cannot be easily separated to good practice which is liberating and damaging practice which is enclosing. Liberating and damaging practice are concurrent, they are inextricable; every practice incorporates both sides. Practice implicates us and we need to keep redoing it in order to escape it. In a sense the antidote to practice is practice itself. Again, the antidote to damaging and enclosing practice is not liberating practice—this is a false dichotomy; we are implicated, we do good and we cause damage. Practice is relentless and unyielding in "I-do-not-know-how-to-call-them" societies. In order to repair the damaging practice, one cannot just bet on its other side only, one needs to change practice, to experiment with it, to rewild it. Experimentalism in *Experimental Practice* is not about uncertainly, flexibility, risk, unpredictability, preparedness. It is about searching for minor resources in the material make up of our worlds that allow us to rewild practice and to activate novel practices in motion. Practice is always material and technoscientific (as it is social of course) but it is experimentalism that allows practice to reconceive itself and to recreate itself. Until of course it is captured again. There is no ultimate form of liberating practice.

The Scale of Practice

So again, what is then practice that is emancipatory, liberating, transformative? Or perhaps the right way to ask the question is how much practice do we need to change things? What is the scale of practice? What scale of practice do we need if practice always implicates us? Practice always evokes scale and scale is about modifying practice to become

transformational across large parts of "I-do-not-know-how-to-call-them-societies." This is a topic that is raised by Pellizzoni and Raffaetà: "How can major infrastructural changes or large technoscientific projects be challenged by the [practice] of crafting from below and on the ground?" How can we scale up alternative and community technoscience? How can we radically democratise technoscience? The problem with scale is that it is an ambivalent concept, we need scale to encounter the depth and width of socio-ecological destruction and simultaneously we know that scale is the engine of productionism and productionism is the tool of growth which is a major cause of ecological destruction. In a shortcut, scale is linked to destruction. And yet, there is something plausible about scale: we feel that without scale there is very limited scope for meaningful ecological change. Scale is an ordinary concept as it speaks to our sense of planetary belonging. Different humans are situated in many different niches that make them ontologically diverse, but diversity coincides with the everyday sense of belonging to the ground I stand on and for many, increasingly, this is Earth. We need a significant change of scale to reduce carbon emissions, reverse biodiversity loss, eliminate pollution and toxicity, and instigate transformative societal programmes. Scale is not only tightly connected to environmental destruction but is also a plausible affective ingredient that many humans feel is necessary for avoiding catastrophic futures.

It is this ambivalence of scale that makes it so valuable for political strategists of every kind and taste: those who use scale as a proxy to revolution, overcoming capitalist productionism; those ultra-neoliberals who use scale to intensify and invent new modes of value creation; those statists who need scale to preserve the elitist make-up of liberal Global North societies (in a moment of turbulent decline); and those autocrats who use scale to consolidate and expand their power. The ambivalence of scale is easily compatible with so divergent approaches: the revolutionaries, the neoliberals, the liberals, the autocrats. In *Experimental Practice* the immediate feeling that without scale there is no viable way to encounter ecological destruction is a strong motivation for opening up technoscience to other constituencies, communities and social groups. Simultaneously, *Experimental Practice* recognises that scale is often deployed for something else as it is just attached to political strategies, perpetuating the problem that scale would ideally try to overcome. The problem with scale is that you need it but when you have it, it undermines transformational socio-ecological change.

Experimental Practice is inspired by the practices of many different social movements with, within and occasionally against technoscience in engaging with the double bind of scale: for many of these movements scale is not about replicating the same type of action in order to create change. Rather, it is about engaging with the direct conditions and developing alternative ontological conditions of existence, alterontologies, on the terrain on which each one of these movements and communities live.

Rather than copying and repeating the same practice to scale it and attach it to one or another of the political strategies described above, alterontologies proliferate in intensive ways on the everyday life of communities. Experimentalism is not about replication (something already discussed extensively in STS, see for example, the work of Harry Collins, Trevor Pinch, Karin Knorr Cetina, Ian Hacking, Thomas Gieryn and others). This because, in order for replication to create the scale, another process is underway: delocalization. Operationalise, purify and leave behind many of the actual conditions that made the experiment possible. Scale generates the one model that dominates many locales.

Experimental Practice promotes an alternative approach to scale: different experiments emerge in different communities and many of these, despite their significant differences, align with each other to create alternatives on the ground (and there are many historical as well as contemporary examples mentioned in *Experimental Practice* that I do not have the space to discuss here). Are these alterontological practices enough to create sweeping societal change? Perhaps at some point, but possibly not. They are enough though to defend and maintain the life of communities facing social-ecological conflict and destruction. Alterontologies are not prefigurative politics. They do not point towards some short of other global politics of transformation to come. There is no "post" in alterontological politics. Their intensive material engagements is all there is. But a proliferation of such radical transformative practices through community specificity, material singularity and practical concreteness is what creates change: many alterontological practices. Many immediate involvements in creating alternative ways of existence. Rather than replication we have many intensive and concrete involvements. The political significance of alterontological practice is not emanating from an alignment with the politics of revolutionaries, neoliberals, state liberals or autocrats; their political significance emerges from the immediate fact that they engage technoscience and other traditional forms of knowledge to secure communal life in midst of socio-ecological conflict. They create alternatives on the ground. Perhaps, as Ghelfi says in his commentary we can learn from the autonomy of migration thesis which teaches us to see movements before the order of capital production and mobility before the imposition of control. In a similar trajectory, we can say that experimental practice comes before value production and alterontologies before the securitisation and enclosure of technoscientific knowledge.

The Songlines of Justice

Therefore, if there is no overarching politics, then what drives experimental practice? Which ethics does the ethos of experimental practice entail? *Experimental Practice* argues that the ethos of practice rests on a sense of justice. There is no experimental alterontological practice without such sense of justice. Of course, there is then the question where this

sense of justice is grounded. This is something that in different ways seems to be a concern in all three comments, in particular about the grounding of the ethos of practice in a sense of immediate justice without the mediation of a larger political project or a normative framework for justice. All comments ask, and rightly so, where does this sense of justice come from. They also highlight that an ethos of practice can be easily appropriated by mainstream political projects. It is of course true, as discussed earlier, that alterontological practices are often appropriated in the accumulation regime of Global North "I-do-not-know-how-to-call-them-societies" especially when they are "offering goods and services that the market and the state are unable or unwilling to provide" as Pellizzoni emphasizes. Even more so as many alterontological experimental practices come later to become the engine of the economy and to become fully embedded (although it is also important to mention here that many do remain autonomous). But what is crucial for *Experimental Practice* is not whether alterontologies eventually are appropriated or not but, whether while they are enacted, they maintain the life of communities which are under threat through social and ecological conflict. It is a form of ethopoiesis and care ethics as Maria Puig de la Bellacasa has developed it. Alterontologies are driven by an ethos of practice and a sense of justice that are grounded in moving communal experience.

The justice in practice comes in tracks that are handed over from movement to movement, from generation to generation, from community to community (be it actual or virtual communities) rather in a universal code of practice; it comes in transversal paths and imperceptible routes rather in the monolingual political ideologies and visions. Inspired by oral traditional knowledges, the Aboriginal people's songlines and everyday storytelling, one could say that justice comes in practical tales and in songlines rather than in normative scripts. Songline is the mode of (practical) justice. A moral economy in E.P. Thompson's sense that is experienced and enacted and is given in the actual practices of doing and making. The songlines of justice involve place and are recorded in matter. Every community, every movement, every alterontological experimental practice relies on such songlines to exist. This is their moral compass. No movement, no community, no experimental practice operates in vacuum. We are used to think that practice is not grounded on an ethics and politics if this does not revert to normative and contractual principles or to large ideological political projects (as those mentioned earlier). But most of practice, especially experimental alterontological practice, is grounded on an ethos that is given from previous movements and communities, an ethos that travels through experience. As songlines criss-cross each other, their meeting points produce singular forms of practice and experience enacted within the concrete conditions of existence of each experimental community. Practice operates in a densely populated terrain where the experience of one community or movement becomes *continuous* with the experience of others (an idea the Niamh Stephenson and I have devel-

oped in a previous book on *Analysing Everyday Experience*).

I am here interested in rewilding practice by approaching it through the experiences of movements and communities. Rewilding as an ecological practice in conservation biology requires scale in order to counteract species extinction and the loss of habitats and diversity in ecologies. Without scale rewilding is not possible, as animals travel long distances and material flows cross over isolated locales to other ecologies. The rhythms and cycles of animal and material movements, in ecological rewilding, is more than a metaphor or an inspiration for practice. Rewilding, as a conservation method, is not only about helping declining ecosystems to regenerate: it is also about redefining the position of humans in these ecologies. Practice (that is experimental and alterontological practice) exists in scale, but on a scale of many intensive singular experimentations across different movements and communities. Such experimental practices materialise long path of justice given through previous movements and communal organisation. The songlines of justice exist and are handed over as they are enacted through experimental practices, that are all held in common. Songlines need to be nurtured, cared for, and practised. "Omnia sunt communia." Rather than taming practice as representation of a normative form of justice, or as an activity that aims to materialise some dominant political ideology, the experimental practice of alterontologies is linked to songlines sustained by the experiences of previous social movements and struggling communities. These long experiential tracks of social empowerment and ecological care revive and rewild practice again and again.

Digitization of Ecology and Ecologization of Media

Going Beyond ICT Environmental Impact

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Abstract: Digital media and the environment pose some of the most urgent social issues of our time. Nonetheless, the relationship between them is often neglected and merely addressed in terms of impact. This scenario frames these topics in a chiastic relation, thus enquiring two processes: the digitization of ecology (both as a science and as a socio-political practice) and the ecologization of digital media (both in the sense of their greening and of their evolution into mediascapes). On one hand, by drawing on the Ecology of Information Infrastructures and the Actor-Network Theory approaches, environmental issues will be considered as a matter of digital communication and participation. On the other hand, the troubles of digital societies will be addressed from an environmental perspective, adopting the SCOT approach, and embracing the Media Ecology tradition to outline and call for digital sustainability strategies.

Keywords: digital media, ecology, environmental informatics, dematerialization, green IT, mediascapes

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1. Looking Beyond Impact

For at least fifteen years, issues concerning either the environment or digital technologies have been prevailing in the public debate. On a daily basis, news, reports, political statements, and many other kinds of information instruct us about risks and opportunities deriving from our ecological or digital behaviours. A small example displaying the extent of this process is that among the 23 words of the year chosen by the Oxford

English Dictionary between 2004 and 2019, five of them related to digital media and four to the environment (Oxford English Dictionary 2020). Despite the wide attention directed to ecology and digitization as single issues, the public as well as mainstream media seem much less interested in their possible relationships. On top of that, when a relation is built, most of the times it addresses information and communication technologies' (ICTs) environmental impact in quantitative terms.[1] The aim of the following pages is precisely to overcome such an approach through Science and Technology Studies (STS), providing an alternative perspective on it and, most importantly, identifying other possible connections between digital media and the environment.

Thus, two processes will be inquired: the digitization of ecology (both as a science and as a socio-political practice) and the ecologization of digital media (both in the sense of their greening and of their evolution in terms of informational environments). At a first glance, this reversal might appear as a mere exercise in style but crossing words in a chiastic relation might provide useful insights: this paper invites to consider environmental issues as a matter of digital communication and, conversely, to interpret digital society's troubles from an ecological point of view. These tasks require a multidisciplinary gaze that, drawing on different theoretical perspectives, spans from sociology of science to environmental sociology and media studies.

In particular, digitization of ecology addresses how digital technologies affect both the production of environmental knowledge and the participation into ecological issues. As such, digital ecology first implies a sociology of science tailored on the community of environmental scientists and on their research work. Here the ecology of information infrastructures (henceforth: EII), and particularly Susan Leigh Star's work, represents a sound perspective to adopt. By inquiring the production of scientific knowledge through a relational lens that highlights the tension between universalistic vocations and situated practices, EII allows to see digital technologies as a crucial but unstable information infrastructure for environmental scientists, whose analysis can shed light on the current environmental debate. Secondly, digital ecology also pertains to environmental sociology and media studies, as it calls into question issues con-

[1] Emerging as a field of research in the 1990s, ICTs' environmental assessment represents the earliest and most common approach to the relationship between digital technologies and the environment. Providing a balance of direct effects in terms of energy use, resources consumption and waste production, ICTs' ecological impact is a technical and multidisciplinary subject, traditionally embraced by "hard" sciences such as industrial ecology, energy engineering, and informatics. Social sciences have sometimes contributed to this field by adopting a quantitative approach to evaluate ICTs' indirect effects. Inquiries into other kinds of relation between ICTs and the environment have been only marginal (Mol 2008, 10-16).

cerning environmental information and participation. Recurring to insights from Bruno Latour's and Noortje Marres' work in the frame of Actor-Network Theory (ANT), digital media can be seen as a broad array of hybrid and socio-technical networks, in which human and non-human actants interact according to different logics with different implications. Together, EII and ANT can help to understand the role of digital technologies in producing environmental knowledge as well as in facing the environmental crisis.

The ecologization of digital media pertains to two further and distinct processes inherent to media studies. First, it refers to the influence of environmental concerns towards the evolution of digital devices and infrastructures, whose greening, i.e., the mitigation of their own environmental impact, has been occurring through several socio-technical innovations. Following the tradition of Social Construction of Technology (SCOT), this process emerges as a battleground in which different social groups struggle to affirm their technological framework through different practices and values. Finally, to speak of ecological digital media also means looking at their evolution in terms of mediascapes, i.e., informational environments installed into the physical space. In this sense, the Media Ecology (henceforth: ME) tradition represents a crucial tool for understanding this process, the digital issues it raises and some possible solutions. Addressing green/ecological media through SCOT and ME will allow to understand whether and how environmental concerns affect the development and use of digital ICTs.

Digital ecology and ecological media thus represent two wide and challenging subjects, which often overlap rising possible misunderstandings. For this reason, the next section specifies the meaning assigned to key terms like "ecology" and "digital media". The following four paragraphs address the issues of digital ecology and ecological media by reflecting on selected literature revolving around EII, ANT, SCOT and ME, and by putting forward some thought-provoking arguments. Finally, the conclusive section summarizes the key points of this scenario.

2. Ecologies and Digital Media

When talking of ecology, we will refer both to the namesake scientific discipline and to those socio-political practices often labelled as environmentalism. While being aware of the many differences occurring between them, it is important to remind that a radical distinction is not adequate, given how complex, heterogeneous, and intertwined these two domains are. Environmentalism acts as an umbrella term for many different things such as, among others, nature conservation, the rise of green political parties, environmental information, communication, education, and activism (Nebbia 1999). Furthermore, all these activities derive from scientific ecology, a multidisciplinary field whose epistemological status, classifica-

tion, and affiliation are controversial, having often changed over time accordingly to the dominant paradigms and to the scale of observed events (Bellamy Foster and Clark 2008). Spanning from the atom to the ecosphere (Odrum and Barrett 1971, 4-7), ecology appeals to physics, chemistry, biology, geology, climatology, and many other natural sciences. In addition, it has several concrete applications in the fields of engineering and industrial production. Being a domain in which modern separations show up with all their artificiality (Latour 2012), we will use the term "ecology" in an inclusive way, referring to diverse environmental sciences and to the several social practices they inform.

As a hybrid science whose main subject are relations, ecology has also inspired many approaches to social reality, including EII and ME. Neil Postman (1970, 161) defined the latter as "the study of media as environments", urging to deepen into "the interaction between people and their communications technology" to understand how these "affect human perception, understanding, feeling and value". Thanks to the "powerful metaphors of media as ecologies and environments" and to "its focus on the materiality of technological artefacts" (Trerè 2019, 44) ME is a valuable tool to inquire the ecologization of digital media as mediascapes. On its turn, EII goes beyond media to bring human agency into play and to "include the network of relationships, values, and motivations involved in technology use" (Trerè 2019, 41). In their seminal work, Star and Ruhleder (1996, 117) clarify that "the term ecology (…) refers to the delicate balance of language and practice across communities and parts of organizations; it draws attention to that balance (or lack of it). It is not meant to imply either a biological approach or a closed, functional systemic one". To avoid possible misunderstandings, it is important to remark that the word "ecology", both in ME and in EII, is a matter of method, rather than content.

While referring to ecology in a broad and metaphorical way, our analysis needs to narrow the category of digital media both in meaning and in time. On a conceptual level, we exclude digital codes, as these comprise all communication systems made of discrete units, including, for instance, the human language. Rather, we identify digital media with those devices and infrastructures that allow information processing through electricity (Granata 2009, 107-108). Still, we further need to narrow the temporal field. Starting from electricity's informatization, in fact, would imply to consider technologies such as the telegraph, the radio, the television, and electronic calculators, whose relationships with ecology are out of our scope. Rather, we trace a meaningful turning point for digital media history back to 1969, when packet switching was successfully tested to send a message across the ARPANET, the first computer network. That experiment marked a symbolic watershed, starting a qualitative change hardly spottable at any other time in the evolution of digital devices, which could now exchange resources between them and increase their computational power through the network. Somehow, they started talking to each other,

and not just to humans. When discussing digital media, the paper will thus refer to digital connectivity's devices and infrastructures, calling into question mainframe and personal computers, laptops, smartphones, as well as early computer networks, software, the Internet, the World Wide Web, and mobile apps.

3. Digitizing Ecology

3.1 Environmental informatics as unsteady information infrastructure

It is common belief that scientific knowledge benefits from digital technologies, as these allow accurate measurements, faster field detections, complex data processing and a better communication within the scientific community. Environmental scientists embraced this view from the beginning, extensively drawing upon computer applications for environmental monitoring and control. The application of information systems to ecology dates back at least to 1975, when the first text in the field was published under the title *Computer Techniques in Environmental Science* (Ouellette et al. 1975). Today, the marriage between ecology and digital media is solid as ever, being structured in a specific discipline called Environmental Informatics (Hilty 2014). Nevertheless, from the ecological perspective of information infrastructure, the relationship between science, including ecology, and technology seems much less taken for granted and much more problematic. In particular, if we consider that "an infrastructure occurs when the tension between local and global is resolved" (Star and Ruhleder 1996, 114), one can argue that environmental informatics have never been a stable information infrastructure, given that such a tension continues to persist.

This is particularly evident in climate studies where, despite an ever-increasing amount of information has been digitally processed, consensus still lacks, making the climate change debate a political issue of global relevance and an ongoing scientific controversy. As a science enquiring a global phenomenon, climatology's development is strictly connected to digital networks. Not by chance, it has been among the first fields in ecology to exploit computer networking from the very beginning. Global climate dynamics simulation and modelling, and air pollution risks are the only environmental projects listed in the *ARPAnet resources handbook*, a directory of research institutions connected through the ARPAnet (Feinler 1978, 297; 312; 565). The relationship between climatology and informatics is thoroughly investigated in Paul Edwards' book *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (2010). Here the author retraces the whole story of global climate knowledge, showing that digital media helped in *making global data*

(Edwards 2010, 187-227) but at the same time posed difficulties in *making data global* (Edwards 2010, 251-285). This means that while digital technologies lessened *data friction* (i.e., the process of gathering data collected in different times and locations), they also enhanced *metadata friction* (i.e., the inconsistency of those data's original, local context). Such enhancement is not depending on digital technology in itself; it is rather the consequence of how scientists conduct their work through it. Researchers always omit some metadata, for either technical limits or negligence, causing metadata friction to other scholars. Retaining the context, moreover, is a sensitive issue concerning every discipline, including other environmental sciences (see, for zoology: Star and Griesemer 1989; for biodiversity: Bowker 2000; for taxonomy and genetics: Waterton et al. 2013). Nonetheless, by connecting very different contexts across the world, digital media have highlighted the inconsistency of situated scientific practices. At the same time, however, the scientific community envisioned a possible solution in the same digital technologies.

To reduce heterogeneity and to adjust metadata for making them global, as Edwards (2010, 188) puts forth, "scientists developed suites of intermediate computer models that converted heterogeneous, irregularly spaced instrument readings into complete, consistent, gridded global data sets". Computer-aided data models "are really a vast family of mathematical techniques, algorithms, and empirically derived adjustments to instrument readings" (Edwards 2010, xv). Recalling Bowker and Star (1999), Edwards names these continuous efforts to recover original metadata and to build comprehensive datasets as infrastructural inversion. This is "a long and painful process [that] began in 1970s [and through which] climate scientists turned the climate record upside down, reexamining every element of the observing system's history, often down to the level of individual measurements" (Edwards 2010, xvi). Nonetheless, infrastructural inversion through data models poses the same problem again, but on another level. Different scientists and laboratories always create different data models, starting some kind of "data wars: rather than one definitive global dataset, multiple, competing data sets will emerge" (Edwards 2010, 435; see also: 287-322). In short, digital technologies allow gathering larger volume of data, but they cannot guarantee the consistency of their original contexts: on the contrary, they highlight incoherence. Moreover, when used to recover the context or to correct previous detections, digital technologies fuel further debates because they allow multiple ways to do that.

This is exactly where the widest and most urgent environmental issue of our time is stuck. Climate change supporters and deniers are such according to the (meta)data they collect and elaborate, a process that increasingly happens through digital media. Of course, economic and political interests play a major role in this debate, benefiting from the lack of consensus. Nonetheless, the crucial point is that the two factions support their thesis through some kind of digital data: somehow, climate change is

a digital issue. The same applies for other ecological controversies, as those connected to pollution, contamination and toxicity issues in which risk thresholds are heavily debated.

Environmental informatics is thus an unstable infrastructure, which has not yet stabilized, and which is still in inversion. Environmental scientist should take it less for granted, focusing much more on its situated use. Following Bowker and Edwards' suggestions, they should increasingly cooperate with social scientists and with each other by building stronger international institutions and information infrastructures. For climatology, the institution of the Intergovernmental Panel on Climate Change (IPCC) in 1988 is a first step in this direction but, given the ongoing and multiple controversies, there is still a long way to go.

3.2 Non-human agency between material participation and dematerialization

Besides environmental sciences, digital media play an increasingly relevant role into environmentalism, as they evolved from mere informational tools to complex participatory systems. While media studies allow to identify the most important stages of this process, to integrate environmental sociology with the ANT attention towards non-human agents sheds light on its implication, both in terms of participation and effectiveness.

Before the 2000s, digital media have had a limited impact on environmental information and communication. Until the end of the 1980s, in fact, computer networks mainly concerned tech companies, armies, and the scientific community, with the public having little or no interest in them. Even with the advent of the World Wide Web and with the increasing accessibility of home computers and connections during the 1990s, the information retrieval still reflected a top-down structure and followed a "navigational" path, being filtered by search engines and limited at few institutional websites (Rose and Levinson 2004). Accordingly, digital media acted similarly to traditional media, providing people with generic environmental news.[2]

A more relevant shift towards digital ecology happened around 2004, with the development of the so-called web 2.0, a renewed Internet architecture that encouraged and simplified user-generated content. As blogs, wikis, and social networks did not require any advanced computer skills, many more people could now upload their own resources and share it among peers and strangers, turning the information structure into a bottom-up model featured by co-creation, dialogue and prosuming dynamics. For ecology, this opened a myriad of possibilities, gradually turning

[2] Traditional media, however, have had a profound influence in setting the environmental agenda (see Anderson 1997).

digital media from informational devices into participatory tools (see Mol 2008; Anderson 2014). Online forums or social media groups, for instance, allowed setting up protests or exchanging "sustainable life hacks" within the environmentalist communities. As the ANT scholar and political theorist Noortje Marres (2012, 74-77) points out, this kind of information are calls to environmental action that materialize participation according to the pragmatist motto "the more invested, the more engaged". From an environmental point of view, this particular use of digital media aims at co-articulating the "the amplification of costs, efforts, disruptions, as a way of documenting the 'costs' of environmental change" (Marres 2012, 77). Nonetheless, digital ecology and material participation also respond to different and more problematic co-articulations. In the field of nature conservation, for example, many NGOs and environmental institutions extensively exploited social media to enhance their projects (see Arts et al. 2015) by stimulating users' online engagement in order to collect more data through crowdsourcing and citizen science or to raise more funds through crowdfunding. Turning online engagement into offline activities with concrete implications on the physical environment, however, might lead to a "nature 2.0" (Büscher 2016) which suffers of spectacularization, subjection to neoliberal policies and slacktivism. The latter, in particular, represents a problematic and often useless or even harmful kind of participation, which responds to the liberal logics of the "minimization of the effort" and of the "involvement-made-easy" (Marres 2012, 65-71).

Yet, digital media materialized environmental participation in even more profound and paradoxical ways that sink their roots back to the emergence of the Internet imaginary (Flichy 2007). During the 1990s, a wide use of metaphors featured the public and political debate about digital media, depicting the Internet as a 'digital library', a 'cyberspace', or 'information highways' (Stefik 1996; Bory 2020). Besides feeding high expectations in terms of democracy, knowledge and wealth, the "digital sublime" (Mosco 2004) also caught the environmentalists' attention. Several scholars, companies, politicians and institutions explicitly juxtaposed environmental sustainability, which emerged as a public discourse in those same years, with the opportunities deriving from the Internet in terms of dematerialization (Camorrino 2018). Still today, emails, e-commerce and smart working, to cite just a few digital applications, are often promoted as effective tools for lowering energy and resources consumption. At the end of the 2000s, sharing economy platforms such as Blablacar (2006), Airbnb (2007) and Uber (2009) took a further step towards material participation. Mediating between supply and demand of underused assets through their websites or mobile apps, these companies often magnified the supposed environmental benefits deriving from using their services. An extensive literature, however, proved that all these assumptions were too optimistic, finding out that digital ICTs entail direct, indirect, and systemic rebound effects offsetting their supposed benefits

(Plepys 2002; Gossart 2015).

From an ANT perspective, digital ecology seems to represent an encouraging trend towards environmental sustainability. Acknowledging technology as a moral tool (Verbeek 2011) with an (ecological) agency of its own, digitization of ecology seems to hold Latour's call to "turn our exclusive attention away from humans and look also at nonhumans (…) the hidden and despised social masses who make up our morality" (Latour 1992, 227). Envisaging strong allies in non-human actants such as digital devices, systems and infrastructure, digital ecology might overcome the artificial dichotomy between culture and nature that features both ecological modernization and deep ecology. Nonetheless, digital ecology cannot rely on technology alone. Rather, to succeed in its ecological purpose and to avoid techno-solutionism, it needs to be part of a stronger actor-network, made up of both humans and natural non-humans. Emails and electronic documents alone cannot reduce paper usage if workers are not educated to their proper use; e-commerce or smart working alone cannot reduce air pollution if deforestation does not slow down drastically; and home sharing platforms alone cannot lessen resource waste if they gentrify entire cities. While dematerialization and slacktivism often present themselves as self-sufficient strategies, online environmental communities exploit interconnections and alliances, by connecting people each other, funding associations' projects, educating about biodiversity or sustainable living. These few examples help to point out that digital ecology, to be effectively sustainable and not to fail, should recruit as many allies as possible and build its own context (Latour 1996, 133-134), co-articulating environmental participation in broader terms, rather than limiting it to the technological register.

4. Ecologizing Digital Media

4.1 Greening strategies, from green it to green web

So far, by talking of digital ecology, we addressed environmental issues as a matter of digital technologies, with the latter affecting both our knowledge of the environment and attitudes towards it. We now attempt to reverse the relationship, enquiring whether and how environmental concerns (could) shape digital media's development and use. The reversal might seem abrupt, but the idea of dematerialization we have just gone through is a good case in point.

Besides presenting digitization as a self-sufficient and environmentally sound strategy, the dematerialization myth conceals the multiplication of devices it implies and their materiality. Even if all previous media industries have had profound ecological costs (see Maxwell and Miller 2012, 42-64), none of them embodied the "materiality paradox" (Schor and

White 2010, 40-41) as much as the digital one. As Balbi and Magaudda (2018, 8) point out, "contrary to the argument of dematerialization, digitization has encompassed an explosion of new hardware dedicated to reproducing and storing contents: from computers to telephones, DVDs to USB sticks, MP3 readers to cameras, to cite just a few. (…) The digitization process has actually stimulated the dissemination of material devices". The production, use, and disposal of digital artefacts and infrastructure involve an intensive use of energy and harmful resources, whose ecological impact is controversial but definitely growing. In 2007, ICTs were estimated to be responsible for 1% of global greenhouses gas emissions; in 2018, the value increased to 3.6% with it being projected to grow to 14% by 2040; of these emissions, devices currently account for the 31%, and infrastructures (data centres and communication networks) for the remaining 69% (Belkhir and Elmeligi 2018). If the IT sector was a country, it would rank third globally for electricity consumption (Cook 2017). Also, electronic waste is ever increasing: while in 2014 it amounted to 44.4 million tons, in 2019 it grew up to 53.6. Moreover, its vast majority (82.6%) is not documented and is being dumped improperly or even illegally in developing countries (Forti et al. 2020), causing enormous damages to the population and to the environment. Such ecological costs collide with the possibilities implied in dematerialization. As Luciano Floridi points out: "the overall result is that we are taking a technological gambit: we are counting on the fact that ICTs benefit the environment more significantly and quickly than they actually harm it, and that there is enough time for such a gambit to pay back" (Floridi 2014, 213). However, besides its assessment and quantification, ICTs' environmental impact acquires a more specific sociological relevance when observing how it affected the evolution of digital artefacts. In particular, from a SCOT perspective, digital media greening seems to reflect an interpretative flexibility involving different actors, strategies and values (Bijker et al. 1987).

While the public has been unaware of it for a long time, ICTs' environmental impact is a concrete and long-standing issue for producers and political institutions. Tech companies, in particular, have always been sensitive towards energy efficiency, as it goes hand in hand with devices' miniaturization and simultaneous increase in computational power. This process, which famously aroused the interest of Intel's co-founder Gordon Moore already in 1965, was fraught of economic opportunities and paved the way to the personal computers industry, disclosing an extremely valuable market. In 1992, computers energy efficiency became a subject for the U.S. Environmental Protection Agency program *Energy Star*. Launching its label to promote and certify hardware's energy performances, the EPA stimulated the emergence of an entire R&D sector, the so-called Green IT or green computing, which would have soon developed software solutions like screensavers and stand-by modes. In 2002, two European directives concerning hazardous substances and e-waste (2002/95/EC; 2002/96/EC) put another building block for digital media's

greening. By restricting the use of lead, mercury, cadmium, and other chemicals, and by introducing producers' responsibility for devices disposal, these measures stimulated eco-design innovations and facilitated practices such as computers refurbishing and recycling. Today, given their overwhelming carbon emissions, greening data centres represents the most crucial challenge for the so-called Green Web. As most players in the big tech industry are pledging to become carbon neutral within a decade (The Guardian 2020a; The Guardian 2020b), they are increasingly powering server farms with renewable energy and displacing them in remote locations or even beneath the sea to favour their natural cooling (Microsoft 2020).

Introducing energy and toxicity issues into computer engineering from the early 1990s, ecology has been affecting for at least thirty years the production of digital devices and infrastructures whose current technical shape and organization, somehow, incorporate environmentally sound solutions. Digital media's greening, however, is not yet a closed and stabilized process, as it is also following some divergent paths. Social practices like those encompassed by repair cafes, swapping communities, or the open source movement's aim at extending devices' life cycle and at resisting planned obsolescence through software and hardware manipulation (Jackson 2014). While Green IT combines ecology and linear economy, these social practices embrace very different values, supporting informal and circular economies and posing an obstacle to digital media's traditional market. Still from a SCOT perspective, hackers, activists, and hobbyists seem relevant social groups struggling for their own interpretation of digital devices and technological framework (Bijker et al. 1987). In this sense, the development of modular design for laptops and smartphones reflects an interpretative flexibility that might lead toward a more radical eco-design of digital media, taking into account not only their technical properties but also the social practices they can encompass. Looking at infrastructures, a particularly meaningful example of social greening is represented by Ecosia, a web search engine that, from December 2009 to October 2020, has planted more than one hundred million trees all over the world thanks to its users' online searches. As a social business whose mission is to build a greener Internet, Ecosia devolves part of its advertising revenues to offset its emissions through reforestation projects. The company states to be more than "carbon neutral" and that its website "actively remove[s] CO2 from the air" thus mitigating the effects of climate change (Ecosia 2019). Stating whether this is true or not would be a pointless operation, given how complex, hypothetical, and arbitrary environmental assessments are. Rather, recalling ANT and the previous section, what is mostly interesting about Ecosia is that it pursues digital media's greening by building on a network made of individuals, companies, advertisers, associations, digital infrastructures, devices, and natural entities such as trees.

4.2 Mediascapes and the need for a digital sustainability

As a polysemic expression, the ecologization of digital media also pertains to another, very different and twofold process, i.e., their increasing presence into the physical space and their simultaneous development into informational environments. While the previous section looked at green media through the lenses of SCOT, the focus is now on mediascapes (Appadurai 1990; Casetti 2018) or also ecomedia (Parisi 2019, 37-46), meant as both hypermediated environments and environmental media. Illustrating these concepts and their implications through Media Ecology, digital sustainability could be suggested as a convenient strategy to counter digital pollution, both in its environmental and communicative meaning.

All media – whether they are old or new, analogical or digital – exist as material artefacts that act upon a physical space, transforming it and giving it a temporary or permanent identity. Writing, for example, made archives possible; the printing press gave shape to modern libraries; Lumières' *cinematographe* brought cinema rooms and, later on, drive-ins; billboards continuously change the urban landscape, and television deeply affected the domestic space. Thus, when a medium, or a set of media, defines the essence and the practices of a place – be it a phone box, a game room, or a whole city – we then have a mediascape (Casetti 2018, 118). What is peculiar about digital media is that by enhancing the process of multi-media convergence (Jenkins 2006), they allowed traditional media to migrate into digital devices, giving life to new and hybrid mediascapes. Today, for instance, one can watch a movie in a cinema room as well as at home or on a bench in the street; similarly, one can purchase a music album in a specific store or while eating in a restaurant. The list of examples might be endless. As Casetti (2018, 131, my translation) points out, "even if technologies seem to become rapidly obsolescent, media, today, tend not to die: rather, they relocate. (…) Moving, a medium create a new kind of situation which generates a new mediascape". Over the last decade, because of a huge increase in mobile connectivity and digitized mobilities (Urry 2007), digital technologies filled the environment with informational flows, creating new spaces and reconfiguring old ones. In this sense, digital technologies are deeply ecological.

Even more important, however, is that digital technologies, thanks to multimedia convergence and connectivity, act as a gate to mediated environments, thus becoming virtual environments themselves. Media as environments, referring once again to Postman's powerful words, seems to be no longer a mere metaphor. Digital media's development in terms of informational environments is attested by the words we use when talking of them: *platforms, resources, surfing, web, browser, explorer, windows, cloud, drive* are just few examples explicitly recalling natural elements or spaces of action. Also, use of digital technologies is ever increasing: in 2019, the average global time spent per day on the Internet was 6 hours

and 42 minutes (We are social 2020). The reason why we spend more time on digital media than in real places like theatres, stores, parks, or museums is, at least in part, that through the same technology we can access to increasingly accurate representations of those places. Digital media are deeply ecological in this sense too. Such an intensive use requires to draw data from the Internet, but also to put a huge volume in. Depicting the extent of datafication, Floridi (2014, 13) reports that humanity had accumulated approximately 12 exabytes of data in the course of its entire history until the commodification of computers, but (…) it had already reached 180 exabytes by 2006. (…) The total grew to over 1600 exabytes between 2006 and 2011, thus passing the zettabyte (1000 exabytes) barrier. This figure is now expected to grow fourfold approximately every three years, so that we shall have 8 zettabytes of data by 2015.

These forecasts were extremely reductive. In 2018 alone, the world produced 33 zettabytes of data, with an expectation of growth up to 175 ZB in 2025 (Reinsel et al. 2018, 6). Collecting, storing and accessing this information, of which the overwhelming majority is redundant, has huge ecological costs, as illustrated in the previous section. Nonetheless, it also has social costs: data breaches, mass surveillance, online frauds, hate speech, illegal content, and viral fake news, to cite just a few critical examples, are a kind of communicative and symbolic pollution (Floridi 2020, 71-77) that depends on datafication and, at the same time, contributes to it. These issues are often addressed in technical or institutional terms, assuming digital media as mere instruments and asserting that it would be enough to improve cyber-security, to design new privacy policies or to develop better algorithms. From a ME perspective, instead, it seems more and more necessary to develop a digital sustainability strategy as strong and binding as the environmental one, but hopefully more effective. Increasingly fulfilling and representing the environment, digital media can no longer be considered as mere tools. Rather, we should acknowledge, protect and safeguard them as real environments, limiting the amount of resources to withdraw and to spill over them. This sort of digital e-nvironmentalism (Floridi 2014, 217-220) could take more or less complex forms. It might result, for example, in a digital transnational governance to take digital infrastructures away from private interest, or it could counter irresponsible feeding of algorithms through financial disincentives. Also, digital education programs could contribute, explaining that a clear and neat demarcation between online and offline is no longer possible (Boccia Artieri et al. 2017), and that we rather live an "onlife" experience taking place into an "infosphere" (Floridi 2014, 25-86) in which every action has consequences on the real environment. Educating and struggling for a digital sustainability strategy that, by involving individuals, institutions, companies, devices, and natural entities, could finally consider virtual environments just like real and concrete environments is a crucial challenge for the next years. Ecologizing digital media, in this sense, is not an accomplished process but a goal to pursue.

5. Conclusions

By adopting an STS-oriented approach, the relationships between digital media and the environment show up in all their complexity, going far beyond the impact issue. Digital ecology and ecological media emerge as crucial concepts that shed light on both the ecological crisis and the excesses of digitally mediated societies.

Digitization of ecology reconfigured our knowledge of the environment but at the same time raised new epistemological and political challenges. Environmental sciences benefited from digital media in terms of data collection but not in terms of coherence, feeding lasting controversies. Digital ecology also provided us with great opportunities and tools to live more sustainably and to take part into the ecological crisis. Participation, though, should not be restricted to the technological register. Rather, recruiting human, technological and natural actors, digital ecology could avoid some of its most common side effects. Among these, the environmental impact of digital devices and infrastructures represents an impelling issue.

ICTs' huge ecological costs allows to reverse the relationship and to enquire whether and how ecological concerns affected digital media's development and use. On one side, the ecologization of media is an ongoing process, given that several socio-technical innovations are in place to green digital technologies, affecting their evolution each in a different way. On the other side, though, ecologizing digital media is a goal to pursue. Even if digital technologies increasingly present themselves as mediascapes affecting our lives, it seems that our society is still reluctant in considering them likewise natural environments. A digital sustainability strategy inspired by the environmental one could limit the excessive resource drawing and spilling over, thus reducing digital technologies' environmental costs as well as the growing threats they pose to individual and social life.

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J. Watson
Lo-TEK. Design by Radical Indigenism, Köln, Taschen, 2019, pp. 418
by Andrea Botero

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Christopher William Anderson
Apostles of Certainty. Data Journalism and the Politics of Doubt, Oxford, Oxford University Press, 2018, pp. 228

Valeria Burgio *independent researcher*

Anderson's book is a historic reconstruction of how data are used, in journalism, to build a culture of truth and objectivity. Far from being the exclusive prerogative of Data Journalism, the use of data dates back to the time when sociology and journalism were attempting to build a scientific basis for their undertakings, developing a social research methodology of a quantitative nature. This was especially true of the United States in the first half of the twentieth century. The book therefore reviews the phases of this attempt by journalism to pursue the methodological rigour and mathematical foundations of the more survey-based social sciences, highlighting the mutual mistrust between the discipline of sociology and the practice of journalism. Moreover, it illustrates the difficulties encountered by journalism schools, not only to enter the academic world, but also to include the study of scientific subjects such as statistics in their curriculum.

It all started in the early twentieth century with the growing popularity, in the Anglo-Saxon world, of the survey research: a social analysis based on the collection, through door-to-door surveys, and on the processing of data. In particular, Anderson meticulously examines an American movement that has largely been ignored in academic research, the *Men and Religion Forward Movement,* viewing it within the context of a more general proliferation of quantitative investigation techniques. In a context of religion-based activism and social reformism (hence the reference to "apostles" in the title), the intent became to base a "culture of truth" on data as a form of factual evidence. Both data journalism and empirical survey-based social sciences appear to be rooted in this movement. However, as Anderson notes, the development of social sciences from the 1920s to the 1940s emphasized the disciplinary boundaries that divided it from journalism: as revealed by the author's content analysis on a body of scientific sociological journals of those years, sociology considered journalism to be a lesser rigorous field of social investigation, whose purpose was to create communities of opinion, rather than to conduct social research. Unlike journalism, social sciences, based on positivism, drew increasing inspiration from the natural sciences. Consequently they presented themselves as objective and empirical sciences that sought to "meet rigorous standards of objectivity, verifiability and generality" (p. 88), just like the hard sciences. One way to do this was to observe statistical rigour in the research methodologies, which led to a visualisation of precise and accurate but hard to interpret mathematical models.

A central figure in the book is the journalist and academic Philip Meyer

who, in the 1960s, sought to reconcile journalism and social sciences through *Precision Journalism*, the goal of which was to apply quantitative methods to news reporting. Capitalizing on the developments in computer science, precision journalism based investigative reporting on the recognition of patterns, on the emergence of data correlation and trends. This was a decisively innovative proposition in a news world dominated by the new-narrative journalism of Gay Talese, Tom Wolfe or Joan Didion. Meyer sought "to treat journalism as if it were a science, adapting scientific methods, scientific objectivity and scientific ideals to the entire process of mass communication" (Meyer 1991, quoted at p. 116). Meyer had an intuition (and then confirmation, given that he is still alive) of how important technological development would become to the field of journalism for seeking evidence in news reporting. As machines progressively moved from the back of the newsroom to the front-desk, databases were preparing to become not only useful tools for market research or starting points for fancy visualisations, but first and foremost the epistemological foundation for the practice of journalism.

In the meantime, however, databases had become fundamental tools for qualitative methodologies: Anderson dedicates a chapter to *computational journalism*, a system of news reporting based on cross-checking and an assessment of the coherence between one news item and another based on available databases, hence on semantic and algorithmic criteria.

One of the many merits of this finely documented book is the relativisation of the impact of the so-called digital revolution that began in the 1990s. The change in practices was due primarily to the speed and ease of tracking news, and was not accompanied by a shift in the epistemology of journalism, which had long sought in data, and not just in facts, irrefutable proof of the news. This was already evident in the "discourse" of journalists relative to their own practices: according to a content analysis conducted on publications aimed at journalism professionals, such as *Editor & Publisher* (1907-2016), the new computer technologies and access to databases would not in and of themselves be a guarantee of hewing closer to reality, but might rather accelerate and facilitate existing practices.

Data visualisation on the other hand is not a central argument in this book, whose focus of interest lies more in the epistemological foundations of data journalism than in their translation into graphics. There are however some ideas on the subject that deserve further exploration: the only images in this book are excerpted from *Messages of the Men and Religion Forward Movement* and are a condensation of what not to do in visualisation given that, as Anderson himself points out, they omit numbers and use approximative techniques of visual translation. Despite their scant scientific rigour, the author uses these images to demonstrate the merit of this pioneering movement, which offered visible numerical proof of widespread social problems, thereby increasing public awareness and stimulat-

ing bottom-up policies of a clearly progressive nature. Rather than a truthful representation of reality, these investigations thus served to mobilise public opinion and awaken political consciences. Their role was of a more persuasive nature, in the sense that they relied on a certain type of visual rhetoric associated more readily with advertising than with analysis. Those were the years that Michael Friendly labelled as "the dark age of data visualisation" (Friendly 2008, 529), when data visualisation disappeared from the sciences, because it was considered illustrational and lowbrow, but enjoyed widespread popularity in post-war attempts at informing the public, particularly in Germany, where the pictorial statistics of Isotype were being developed. Because he restricted the geographical sphere of his analysis to the United States, Anderson does not mention these European experiences and omits all information regarding the move from pre-Nazi Europe to the USA, especially in the person of Rudolph Modley. Anderson does however remark on the progress made in the field of visual journalism in the United States in the 1950s, which witnessed a proliferation of magazines rich in data visualisations, such as *Survey Graphics* and *Fortune*, models for contemporary data journalism.

Anderson on the one hand richly documents the history of the development of an ideology, that of journalistic objectivity, which generated something of a sect embodied in a variety of figures in different historical periods: the "apostles" in the title of the book are the journalists engaged in an almost religious search for objectivity and truth. On the other hand, he distances himself from this ideology, which still attempts to stand proudly, and sometimes unquestioningly, against the populist fake-news factory. The "culture of truth" would seek to lead journalism towards a rather simplistic view of how information can become certainty and would omit an important element in the process of newsmaking: the recognition of the doubts, errors and corrections that must be addressed along the path towards reliable reporting. The mechanisms for fabricating "fake news" are in fact inherent in the production logic of contemporary journalism, which is integrated into a social-mediated space, and they cannot be considered to be the product of an imaginary antagonist against which honest journalism must take a stand.

Through the lens of STS, the author expresses his perplexity about whether data alone can guarantee the objectivity of investigative journalism: because databases are often provided by governments, they have certain limits with respect to the phenomena they serve to quantify. Quoting Star and Bowker (2000), Anderson reminds us that databases, only apparently objective, are always the result of a process that in making choices, includes and excludes. In the words of Bruno Latour, "one should never speak of 'data' – what is given – but rather of *sublata,* that is, of 'achievements'" (Latour 1999, 42). Or one should speak of *capta* (Drucker 2011), objects selected and categorized by someone towards a specific end, rather than fragments of reality.

The chronological account of the evolution of the culture of truth in journalism shows that objectivity is subject to historical relativism, and in this sense, the book echoes the famous work by Daston and Galison (2007) on the evolution of the concept of objectivity in scientific discourse: at one period in time it means neutrality and the coexistence of different voices and points of view (the "she said/he said" approach); in another period it meant "second order objectivity", which considers the database as a collection of transparent elements that unambiguously translate facts as they are. In the evolution of his thinking, manifested in the corrections and prefaces to the various editions of his book *Precision Journalism* (which counted four editions, each of them revised and corrected, between 1973 and 2002), Meyer himself understood that the scientific objectivity he aspired to was the prerogative of an antiquated vision of science, and that even social studies on modern science understand scientific data as the result of negotiation and mediation (Latour 1987). As Anderson correctly points out in the conclusion to his book, "The essence of modern science – at least in its ideal form – is not the achievement of certainty, but rather the fact that it openly states the provisionality of its knowledge" (p. 180). That is why the author invites journalists to humbly sustain a "policy of doubt" and to refrain from challenging the aberrations of populism with the presumption of truth, with the risk of being proven wrong when events turn against the hypotheses they sustain: admitting the provisionality of the results, while constantly seeking to move forward and delve deeper, will guarantee credibility and trust.

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Alberto Ardissone

L'uso delle tecnologie in sanità. Il punto di vista del paziente cronico. [The use of technology in healthcare. The point of view of the chronic patient], Milano, Angeli, 2018, pp. 206

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As *Tecnoscienza*'s readers will know, the theme of the relationship between technology and health has been an important issue for a long time. The theme is characterized by its breadth and the many implications that health has in daily life. We have become increasingly aware of this relationship during the Covid-19 pandemic that has transformed everything: work, relationships, well-being, economy, international relations, even the wars active around the globe.

Alberto Ardissone explores the relationship between health and technology, as well as an array of connected complexities, observed in the pre-Covid-19 period. He focuses particularly on the choices of patients with respect to the search for information about their health through the Internet. The topic has become relevant in recent years to understand how people's awareness changes in relation to the possibility of exploring their own health thanks to blogs, peer groups, second opinions, tips about medicinal drugs, informal chat about health and much more.

The book is divided into two parts.

The first part focuses on an analysis of Internet access and citizens'/patients' health information. The second part describes the results of research conducted online on a variety of Facebook groups attended by chronic patients and concerning specific diseases.

In the first part, the book acknowledges the importance of the Internet for the contemporary era and defines a series of opportunities and complexities that this exposure to digital information can assume for patients suffering from chronic pathologies.

This massive exposure to the Internet is impressive for its rapid development and for the potential it can offer to citizens/patients, but at the same time it also defines a progressive loss of organizational boundaries as well as those between public and private life. This description is followed by a presentation of some theoretical lines of enquiry that the author considers central for analysing the context of digital health.

The author introduces a review of sociological theorizations that allow him to grasp/study technological development in relation to the role of citizens/patients. He distinguishes between the techno-supportive approaches whose points of synthesis can be found in the label of "patient empowerment", and the conflict-symbolist approaches whose gaze focuses on the limits of the rationalist approach.

The first branch of approaches is defined in relation to "techno-euphoric" analysis that emphasize the triggering role of technology in developing patients' knowledge and ability to take care of their health needs. The goal of economic savings and (estimated) improvement in the quality of health services certainly stand out among these approaches. Thus, the reference to the "empowerment" becomes a *passepartout* that will help patients to increasingly improve their knowledge and their ability to interact competently and appropriately with their own bodies. This is even more true with respect to the ability to manage one's own health needs starting from the vast amounts of health data that are increasingly available and shareable.

The other areas of approaches include interactionist, culturalist and constructivist views exploring new complexities for health and well-being. Among these, the author includes the contributions of critical sociology, specifically the socio-material approach that connotes Science and Technologies Studies (STS). Through a quote from Lupton (2014, 610) it is recalled how "technologies are defined as material actors in relation to human actors whose outcome results in a plurality of assemblages between humans and technologies for an infinite combination of material and non-material, of human and non-human" (p. 32). A brief section seeks to reiterate the role of this approach in understanding technology-patient interactions in healthcare. It has been crucial in recent years to recognize the processes of co-construction of technologies in healthcare by reclaiming the temporariness of the balances that this relationship manifests. The reference to STS goes so far as to include the latest labels by Lupton (2017) that focus on the definition of "affective atmosphere", an expression that wants to emphasize the intimate value that can be generated in this relationship. Or even referring to other Lupton's works the author recalls the pervasiveness of human-non-human interaction that now seems to unite many experiences through various types of wearables.

Another window on critical approaches is reserved for the concept of bio-politics that defines the weight of political power to every aspect of human life, recalling in it the pervasiveness of market logics in every social sphere. This approach indicates how the stimulus and marketing policies aimed at the proper management of one's own health should be considered as an extension of the influence of neoliberalism that pushes patients to consider themselves customers and to become entrepreneurs of their own health.

In addition, the book includes among these approaches a reference to the "surveillance society" by which attention is directed to the increasing penetration into daily life of the technologies and practices needed to record, probe, monitor, and discipline people's behaviour.

A final section of approaches to the study of digitisation is reserved for interactionist perspectives that draw their inspiration from Goffman's

work. This view, the author reminds us, is very useful to recall the complexity that is generated between the standardisation processes of centralised and unifying procedures of digitisation systems compared to the specificity of individuals, their clinical histories, and their representation of the state of well-being and illness.

At the end of this review of approaches, Ardissone proposes an "integrated" approach aimed at grasping the multifaceted viewpoints required when dealing with a complex issue such as digitisation in health care. He promises to draw on these points of view in the research to follow.

The research presented relies on a survey conducted with over 2,000 patients/citizens in Italy. The research aim was to offer at least three different layers of analysis: the socio-demographic characteristics of these users; the trust they place in the apps aimed at the Facebook group's chronic diseases; and, finally, the intent of those who turn to the Internet to find information related to their particular health condition.

The results of the survey help us to understand how the Internet is a "particular" gateway. The data shows that more educated people look more carefully at the sites of medical societies, while less educated people look more widely at generic sites. The more educated show a greater interest in being involved in decisions about their own health. Age seems to influence mainly the demand for "second opinions" and more generally to be more active in these types of groups. With regard to the gender of the respondents, the research confirms that it is women who want more comprehensive information and prefer the websites of scientific societies, while men choose their own sources quite indifferently. The research then develops through a series of elaborations proposing and/or recovering a series of labels also discussed in the literature. For example, it highlights how lurkers are mainly the most educated and the youngest in these thematic groups.

Among the results, it is worth mentioning the confirmation that the use of specific apps for one's own chronic pathology – more prevalent for males and younger people – allows patients/citizens better autonomy from the dominance of specialists.

Thus, the work developed in this book can be very useful in understanding some of the complexities of the relationship between the web and the search for data related to one's own health by chronic patients, as well as by family members who turn to the network to understand more about the illnesses of their relatives/friends.

The main path of exploration of the book is consistent and allows the author to summarize approaches with a theoretical framework developed in recent years concerning digitalization in healthcare. The book is also characterised by being a tool for exploring the theme and a series of related phenomena that are also characteristic of the Italian scene. Finally, among the merits of the book we can certainly include the research, which involved a large group of patients/citizens, representing members of about

190 Facebook groups.

Turning to the less successful parts of the book, we can first of all mention the book's title: *The use of technology in healthcare*. One of the risks the reader might encounter is to expect coverage of the vast presence of information technology in healthcare, which is of great interest in the field of medical informatics, sociological, and sociotechnical approaches. In this book, however, the idea is to explore the more specific phenomenology of people who search for health information on the web and who, because they are chronic patients, are interested in becoming more informed through the experience of peer groups in order to share information to improve their health conditions. Similarly, the extensive review of approaches to these issues presented in the first part seems only partially to provide the specificity of interest that then emerges in the subsequent research. On closer inspection, it is precisely the focus on technology and the different ways of studying it that could perhaps have been better focused.

At some point, the author argues that, "[c]onsequently, the technological tools of e-Health and m-Health can be qualified as objects produced in precise social, and therefore historical and geographical, contexts, incorporating cultures, needs, aspirations, choices, meanings, policies, constraints and potentials, merits and defects present in those societies. In this way, we can study technologies by first considering their different natures" (p. 41, my translation). This statement, among others, seems oriented to restore a kind of static and non-processual idea of these technologies. As recently recalled by Magaudda and Neresini (2020), the STS approach requires considering technology, science, and the relationship with users as a system of unstable equilibrium. For this reason, Ardissone's work should have considered, especially in the research chapters, getting closer to the contexts in which the online data was accessed, the trajectories of use of this data, which strategies and networks contributed to the production of data in the different communities observed, what caught the attention of group members, and the reasons for this interest.

The symbolic side of such access is well-documented by the research and analysis carried out, but for instance on the point of how technology enters the care processes, imposing its rules and constraints, cannot be solved only by identifying who uses apps or wearables.

STS studies, among others, have shown in recent years that the contexts of health service delivery generate a multiplicity of interpretations and different ways of using technologies (Crabu 2016). In Italy, for example, the telemonitoring service for cardiology chronicity is differentiated region by region and very often integrated by private remote monitoring and sometimes relying on general practitioners. The latter are included among the figures of reference in the survey but without defining a specific section on them to understand, for example, how their role enters into the management of chronicity and the management of information related to chronicity.

At the same time, the inclusion of technology in care processes asks us to take note of the need to recognise the agency of technologies and the political dimension of their existence among us in a plurality of "political" arenas that are far from stable and homogeneous.

Despite these aspects, it is important to acknowledge the book's efforts in exploring the topic in a very broad manner and it has the merit of adding interesting descriptions to the search for health data on the Internet by chronic patients. The digitization processes in healthcare in Italy are still in their infancy. Hopefully, the contributions of those exploring these topics will increase. At the same time, we hope that awareness will increase about how STS sensitivity can provide interesting research questions to understand these emerging phenomena.

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Barbara Czarniawska and Tor Hernes (eds.)

Actor-Network Theory and Organizing (2nd edition), Lund, Studentlitteratur, 2020, pp. 392

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This second edition of *Actor-Network Theory and Organizing* has been updated from the original version fifteen years previously. The book comprises a variety of chapters that draw from Actor-Network Theory (ANT) ideas and tenets, situated in organizational learning and Science and Technology Studies. There are sixteen chapters, most of which describe research in the field from many different countries including Sweden, Central America, Denmark, Norway, Italy, Poland, Finland, the US and the UK. Further added to this richness of sources is the variety of settings. There are examples from engineering to healthcare, which create

narratives to bring ANT ideas alive. As someone with a varied work background, I found I could relate to many of the accounts. The chapters outside my experience were also presented very clearly and accessibly, and were rewarding in their insights. In particular, I found Chapter 4 *Artefacts Rule* a fascinating read, situated in the area of software development, which I would normally have found intimidating and alien. A real strength of the book is that it invites the reader into these different worlds with the purpose to better understand what ANT *does* rather than what it *is*, much like the search for a "spink" described in Chapter 11 *The Making of Knowledge Society*.

The book is framed in Chapter 1 *Constructing Macro-Actors According to ANT*, and describes the development of the Macro-Actor from the work of Callon and Latour. In the first chapter there is historical development from the first to the current edition regarding the political nature of ANT, and reflections on the seminal work *Actor network theory and After* (Law and Hassard 1999) addressing reflexivity and criticality. In Chapter 1, ANT is now positioned as a diaspora of approaches which Law terms "material semiotics". This provides the rationale for the selection of chapters. The authors also highlight the influence of important publications around and after the publication of the first edition, such as Latour's (2005) *Reassembling the Social*, and subsequent, important works that have shaped ANT. The aim is the same as the first edition: "How power emerges through organizing". The authors go back to Greimas as the source for the idea of the "actant", which challenges the notions of heroism and anthropocentrism by introducing narrative trajectories and anti-programmes, expanded upon in other chapters. For example, Chapter 2 *Technological Strategy as Macro-Actor* describes anti-plans in strategic research, Chapter 3 *The Little Engine That Could* draws from a field example to describe anti-programs as engine- and project-programs, and Chapter 8 *Macro-Actors and the Sounds of the Silenced* explores compliance and alignment in the context of the anti-program.

A lot has been written about ANT in the last 15 years; to reflect this in ANT terms, we might see this book as a macro-actor. My own experience of navigating ANT has been through building networks of ANT-in-the-field experiences, and the theoretical connections developed through situating ANT, and finding my own path through journal articles, blogs, and conversations. I would argue that the publication of the new edition of this book serves to develop other networks around how these ideas are enacted in different situations. The works within *Actor-Network Theory and Organizing* have formed part of the networks and will continue to do so, but there is always the dilemma of situating the knowledge in the "now". Chapter 3 does this by providing a commentary. Updated references and appropriate amendments to terminology are included in the remaining chapters, notably in Chapters 5, 6, 9, 10 and 12. The chapters are the same as the first edition, with the omission of *My name is Lifebouy*

by Lena Porsander and *Explaining the Macro-Actors in Practice* by Peter Hagglund. Chapter 16, *Actor-Network Theory, Organizations and Critique* by Rafael Alcapipani and John Hassard, is a new addition to the current, second edition. This chapter is a reflection on developments in ANT from ANT and after, and theorises about the applicability of ANT to Management and Organizational Studies and Critical Management Studies in terms of symmetry and performability.

In the second edition, many of the chapters follow Latour's (1996) *Aramis* and Mol's (2002) *Body Multiple* in their weaving together of events over time, and emulate Law's notion of ANT stories. In that sense I would argue that the chapters hang together by tracing and retracing ANT themes to build a more detailed and in-depth picture, but the chapters do not need to be read in a particular order. In Chapter 3 *The Little Engine That Could* there is a real sense of "what happened next?" and "how do we make sense of this?". The chapter draws out an engaging story of engineering operations, referring to Latour's sleeping policeman and bulky hotel keys. The operational aspects are very accessible and well described, which would allow non-technical readers to appreciate the details in the field. The timings, risks and scale of engineering activities are conveyed in such a way that brings across the importance of how humans and non-humans are considered. Chapter 8 *Macro-Actors and the Sounds of the Silenced* draws from a constellation of examples such as the use of CS spray in the UK police force and Swedish food wholesaler's practices, to demonstrate programs and anti-programs. In Chapter 15 *Net-working on a Neonatal Intensive Care Unit*, transcript excerpts are used to examine three sequences of events in a Neonatal Intensive Care Unit in the UK to develop an ANT story. In this chapter, the distinction between complexity and complication is presented, alongside how to "cut the network". This leads on to the discussion of Serres' blank objects/quasi-objects which circulate in social relations. Chapter 2 *Technological Strategy as Macro-Actor* explores the interconnectedness of strategy and humaneness in the context of ANT's notion of symmetry, and against the backdrop of technology strategy research. This chapter makes some very interesting observations regarding how language indicates humanness, for example, through the development of "skills". The chapter puts forward an approach to strategy which is more performative, and shifts the focus away from strategy as a purely human endeavour, following the "practice turn" in strategy theory.

Stories unfold in subsequent chapters, weaving in some of the well-known aspects of ANT such as symmetry and black boxes. In the setting of human resources, Chapter 6 *The Organisation as Nexus of Institutional Macro-Actors*, a challenging recruitment situation from a university in Sweden is described in an ANT way, by shifting focus away from human agency. The resulting description plays out the notion of the institution as macro-actor and the trust of the nomination committee as a black box. Black boxes are further investigated in Chapter 7 *Powers in a Factory*, an

ethnographic study of a business is described using the idea of "core sets", and how enrolment in the core set is regulated through the techniques of demonization, demarcating rationality and expertise, and rational emotionality. Callon's work on irreversibility is also drawn from, where networks become black boxes. The story is about mergers and takeovers, and how outward behaviours scuppered redundancy plans. In this chapter, ANT allows for an account without reduction, a retelling rather than a representation. This story also emphasises the constant work required to build and stabilize networks as dynamic entities rather than the reduced representations of causal flow process diagrams. The notion of the black box is extended to the "leaky black box" as described in Chapter 5 *Organizational Routines and the Macro-Actor* and Chapter 11 *The Making of Knowledge Society*, which draws from existing studies of organisational practices in manufacturing and non-profit organisations in the US. By this, the authors refer to the organisational routines as quasi-stable actor networks. In Chapter 11, black boxes are related to part of the Intellectual Capital Project in the government in Denmark. Like Chapter 2, *Technological Strategy as Macro-Actor* really challenges humanness, and examines our motives in the workplace for a human-centred focus, and perhaps explains the reluctance from some to take on ANT ideas such as symmetry.

Different settings and scenarios are presented in other chapters, such as Chapter 10 *The Internet Web Portal as an Enrollment Device,* which explores markets, as well as Chapter 12 *The Reformatting of Electricity and the Making of a Market* and Chapter 13 *Productive Power, Organized Markets and Actor Network Theory*. Chapter 10 describes how internet portals enrol citizens to education in the new market by drawing from economic sociology, which allows for different interpretations of the market economy in terms of choice and state power. Chapter 12 treats the economy as an object within the Norwegian electricity market reform in the 1990s. It draws from the stabilization of variable ontologies, and the ANT notions of translation, enrollment and association. The history of the market highlights how the integrated hierarchy came about, through market reforms and from the move away from state governance and the co-operative market, and toward commodification and internal governance. Chapter 13 considers markets and macro-actors, or actor-networks. It explores conceptions of power in organizational economics and economic sociology in relation to making markets. This is based on ANT and Foucault's notions of power, postulating that power in economic sociology can be conceived of as resource asymmetries in deep structures. The chapter extends Callon's treatment of power through ANT, and presents the market as shaping behaviours and power.

Callon's ideas are further included, most notably with the four principles of translation, in a number of the chapters. For example, Chapter 9 *Materiality and Organizing* focuses on IT systems from an ANT

perspective, and how these can be viewed in an organizational change context where IT is viewed as part of the social structure rather than causal and deterministic. The four principles are applied to draw out significant stages of the project, including power dynamics and the enrollment of politicians. It is interesting to see how the social defines big projects such as IT, and provides an insightful account of when the social and material are brought together. Chapter 14 *Actor-Networks* draws from Callon's four principles to develop two alternative versions of ANT: entrepreneurial and ecological. The entrepreneurial version is played out with a study which investigated an innovation in an Italian Small to Medium Enterprise (SME), and the ecological version describes the implementation of a management accounting system in the Italian Government. Evolutionary theory in relation to ANT is discussed in Chapter 4 *Artefacts Rule* in the context of open-source software projects.

The stories included in the chapters are evocative and engaging, leading the reader by the hand into ANT readings of workplace scenarios, and how this changes how we might "see" the situations arising. This book is a collection of very clear examples taken from the field and presented in narrative form. ANT ideas are interwoven through the stories, bringing theory to life, which is indicative of ANT being enacted as a diaspora of approaches, as well as a sensibility. The book is invaluable to the researcher seeking to articulate ANT in different situations, and to scholars of STS and other disciplines, to expand their knowledge of what ANT *does* in theory and practice.

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Vinciane Despret

Habiter en oiseau [Inhabiting as bird], Arles, Actes Sud, 2019, pp. 224

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Vinciane Despret's *Habiter en oiseau* [*Inhabiting asbird*] is published by Actes Sud in the collection Mondes Sauvages, a collection giving voice to researchers who go in "diplomatic mission" in the world of other living beings. And this is the intent of this book which brings us to the discovery of the world of birds and in particular to the relationship between birds and the researchers who, through the years, have developed theories and methods on birds. She has therefore conducted a thoughtful investigation on the "ecology of thoughts" (p. 55, my translation) concerning birds and their attachment to a territory. Vinciane Despret is philosopher and ethologist. She is an internationally recognized scholar on animal studies and on the relation between humans and non-humans. Her research is often associated to Bruno Latour, Isabelle Stengers and Donna Haraway whose works are mentioned in the book and to whom the book is dedicated. The book can be also related to other STS researches (Callon 1984; Law e Lynch 1990; Law and Lien 2012; Granjou and Mauz 2009) and feminist studies (Singleton 2012) on the sociology of scientific practice in interaction with the animal world.

It is a passionate journey through time at the discovery of how the territory as research object is mobilized in studies facing the same question: what are the "functions" of the territory for birds? According to dominant theories the territory has mainly two functions: assuring food supply and reproduction. Despret's intent here is to give voice to other studies and research methodologies – mainly remained in the shadow – which have taken the distance from those general theories in order to highlight the complexity of the relation between birds and the space they occupy. What these studies have in common is to show the limitation of talking about "functions" and that there is no *one* way for birds to inhabit a territory.

The book is an invitation to slow down in the way of doing research and to acknowledge the multiplicity of birds' modes of existence. As the author claims, the intent is not to become more "sensitive" which does not mean much (and which eventually can even provoke allergies) but to become capable of paying attention and to acknowledge that other beings are worth and entitled to receiving attention. In this regard, she claims sharing Donna Haraway's commitment in becoming with other species and of being "in responsible relation to always asymmetrical living and dying and nurturing and killing" (Haraway 2008, p. 42).

In this she starts by evoking the relationship with a blackbird which comes to her window and has caught her attention by its singing. In this anecdotal episode is the essence of the book. Singing is the only thing that

matters for that bird and is an invitation to attention. But it is also a reminder that our responsibility as researchers is to receive and welcome those others' matters and not to generate them (Despret 2020b).

The book is divided in two parts. In the first one, she introduces the main theories on the birds/territory and some potential counter-stories that deserve attention. In the second part, she elaborates more what these other forms of attention may produce.

In the chapters of the first part, she introduces the research object: the fact that birds settle and develop a specific relation with the space, with a tree which is chosen as headquarter, where they develop routines and organize their living. In other terms, they become territorialized. As she explains, it is starting from the beginning of the 20th century that systematic studies appear and elaborate general hypothesis on the "functions" of the territory for birds. The term territory however is not new and dates back to the 17th century with the first observations on birds' territorial behaviours. On this regard, Despret recalls that it is in that period the idea of territory for humans emerges in connection with land use as appropriation and of property as an individual right. As she explains, if in the ornithological domain a theory of the territory as appropriation was never explicitly affirmed, it is no doubt that a certain terminology referring to the domain of appropriation has been largely used in studies on birds as well as the fact of focusing mostly on birds' aggressive and competitive behaviours. This tendency towards anthropomorphism reaffirms in the 20th century and goes in parallel with methods and practices of appropriation (bird breeding) for aesthetic reasons but also in order to kill them for research purposes. As she claims, the territory has nothing innocent.

The aim is to develop comprehensive theories of the territory, the most important of them are focused on reproduction and assuring food supply. These theories manage to persist in time because either they are simple to observe (like feeding practices) or because alternative studies do not bring to other new general "theories" and therefore most of the time they would not be published.

Despret's intent is precisely to account of the many studies claiming that territory cannot be reduced just to food (or reproduction) and that there would be a bias between food and birds' social organization.

She argues that in mainstream theories everything goes too fast and differences are not sufficiently taken into account. Birds have been approached through pre-established analytical frameworks whereby the tendency is "to silence" rather than listening to them. This tendency is even stronger in the '50s when economic theories are mobilized to explain animals' behaviours. In this period the theory of regulation becomes dominant. It claims that the territory has the function of regulating the population in order to avoid a surplus of specimens on a given territory and therefore limited resources in food. Birds would become aggressive and kill other birds in order to prevent that too many males reproduce, which may

produce a deficit in food. As Despret claims, this theory has been many times falsified. Some researchers show in fact that underpopulation may represent even a bigger risk for the maintenance of species (the human one included). What is rather put forward is the fact that all species are interdependent one another. The theory of regulation is the one closest to the concept of territory as property, but also the one that has encouraged the most brutal practices by researchers who, in order to test it, have killed thousands of specimens. The theory of regulation is therefore understood by Despret as a theory of inattention for not caring about one's own object of research. And this seems even more absurd today in view of the disappearance of species.

Moreover, these theories would be clearly gender biased, limiting female mainly to a passive role. Other researchers have instead observed that also female may become territorialized by choosing a territory – included the male occupying it– adapted for reproduction and also by defending it. Interestingly, then, not only female sing, even if less than males, but their singing would be very elaborated and in any case worth of attention.

In the second part of the book she develops what is anticipated in the first one, that is what do these alternative stories produce? Here the author talks about the territory by referring to Deleuze and Guattari in *Thousand plateaus* ([1980] 1987), that is as a performance or matter for expression.

The interest is no longer to try to formulate comprehensive theories on the territory but to follow and account for the thousand possible ways in which birds become territorialized. Here Despret goes back to some key concepts connected to mainstream theories to better explain her point. Concerning the idea of property, becoming territorialized is therefore not so much the act of making a space "*sien*" ("one's own", that is something that one possesses) but rather "*soi*" ("self") that is an expression of oneself. In this she recalls the central role of singing in this process of territorialisation. The song is way to territorialise a space as well to become with that space. The singing would be then an extension of the bird's body in space like the spider with its web. In this sense there would be a dynamic of reciprocity: "Appropriating a place consists in conforming it to oneself and in conforming to it" (p. 121, my translation).

In the same way, aggressiveness – which was seen as a primordial characteristic of the territory – is also reconsidered in this view. By referring to Deleuze and Guattari (1987), she recalls that "if aggressiveness is a constitutive element of the territory, it does not explain it" (p. 151, my translation). Fights are in fact less dramatic than one thinks and singing plays an important role in dealing with conflicts and in particular in avoiding them. As showed by different researchers it is mostly winners who sing. Showing the quality of the singing and displaying one's own colourful plumage work then as self-promotion aiming to warn potential intruders that going into a fight would be unnecessary costly. The singing is then all about spectacularization mainly addressed to other males, whereby "the winner is not the

best fighter, but the best actor" (p. 63, my translation).

Moreover, the outcome of the fighting would be most of the time already established in advance whereby the intruder almost never wins. So, the author wonders, why do birds keep on fighting? In this regard Despret claims that, if it is true that the territory is a way of organising distance (for assuring resources), in reality it is also a way of creating one's own neighbourhood and sociality. It is said that one of the neglected functions of the territory is the social one whereby fighting is an opportunity to redefine and negotiate what happens at the borders.

In this sense, the territory is a system of conventions which establishes what is allowed and what is not. It becomes then a system of anticipation to simplify complexity and uncertainty. As she explains "the territory only exists through territorialization and deterritorialization since it is always in relation to some entries and exits from the territory that it takes shape. Territories only exist in action" (p. 144, my translation). Territories are then forms which enact and organise relations and give shape to a society. Everything happens in local negotiations and in the composition among different forces. What is affirmed is a performative conception of the territory and the capacity to affect (and of being affected).

In the last part she comes back on the central role of singing in this performative process of territorialization. A territory is proposed as melodic composition or even as partition, that is as a way to organise and distribute singing time with the neighbours of the same species but also with other species, resulting in polyphonic collaborations, or what she calls "expressive cosmopolitics" (p. 176, my translation). In this sense she agrees with Haraway's proposition – after Despret's performative reading (2020a) – of calling our era Phonocene to remind the multiple sonic ways of inhabiting the earth as well the risk for them of becoming silenced.

By inviting us to follow birds' parades and singing, this book brings us also to the heart of the posthumanist debate on agency and on the relationship between human and non-human, on post-qualitative investigations of the relationship between the researcher and their object of research and on ethics and responsibility in doing research in anthropocenic times. This book is an original and engaging reading for researchers interested in these topics.

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Juliane Jarke

Co-creating Digital Public Services for an Ageing Society. Evidence for User-centric Design, Cham, Springer, 2021, pp. 228

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In recent years the Science and Technology Studies (STS) debate about how ageing, technology and society are intertwined is rapidly emerging, as living conditions improve and life expectancy increases, especially in wealthy countries. The growing importance of this phenomenon is extensively supported by EU and national fundings that promote projects to design new technologies and services for the aging society. These research trajectories lay on normative narratives that describe ageing as a problem to fix, and so they lead to an extensive development of assistive technologies that strongly focus only on a medicalized, individual dimension of aging (Cozza et al. 2017). These approaches picture humans as isolated biological machines, forgetting that humans are also (and especially) social beings, made by their relationships with others and the context they live (and age) in. In this context, STS researchers have been fruitful in highlighting two aspects of the phenomenon of active ageing technologies. The first aspect is that STS scholars analyzed how behind the apparent healthy and

positive attitude of the "active ageing" policy concept lay neo-liberal economic logics, of which the "silver economy" represents their intent of capital exploitation towards a specific tailored social group (e.g.: Peine and Neven 2019). The second aspect is that STS analyze design as a phenomenon and designers as key agents in the construction of new collective imaginaries. For example, Lucy Suchman (2007) reminds us that information technologies are "sociomaterial configurations" that join together social imaginaries and materialities. From these two starting points, STS critical scholars such as Juliane Jarke stand for re-configuring the engagement with technology design for older adults (and our older selves). Inspiring social gerontology and human-computer interaction (HCI), these scholars question the representations of "age" that are often scripted into technologies and call attention to the risky consequences of their use, such as the reinforcement of negative ageing stereotypes and social discrimination. Involving older adults at the very beginning of a design process, allows to reconfigure implicit stereotypes, negotiating together with the older participants the "rules of the game", setting common goals and agendas and inspiring enthusiasm, desirability and sense of ownership in respect of the design process and outcome. Designing alternatives to the traditional system design approach of service provider-client opens up to meaningful ways of "success". This is one reason why interdisciplinary research, which includes fields such as design, social sciences and computer science, adopts more collaborative and inclusive approaches to design. In fact, the aim of these research approaches is to co-create strategies and artifacts (digital and not) together with the people that will use them. These projects are grounded in the tradition of field studies, in which ethnographic intents combine with design purposes.

It is the case of Juliane Jarke's book, *Co-creating Digital Public Services for an Ageing Society. Evidence for User-centric Design.* Coming from a very interdisciplinary background (that includes STS studies, Media studies, Informatics and Philosophy), Juliane Jarke has been working since 2014 as senior researcher at Bremen University, where she is also associated with the Institute for Information Management (ifib) and the Centre for Media, Communication and Information Research (ZeMKI). Her research focuses on public sector innovation, digital (in)equalities and participatory design. From 2016 to 2019, she led a work package on Participatory Design in Civic Tech and Open Data in the EU-funded project MobileAge. In this action research project, her research group studied effective methods for co-creating digital public services with and for senior citizens. Her book is at the cutting-edge between STS and co-design, offering an uncommon in-depth account of three co-design projects which are part of MobileAge. Project after project, she builds an incremental narrative of learning outcomes that can serve as guidelines and advice for researchers and practitioners with similar design intents.

The aim of the book is to address the lack of engagement of older adults

in co-design projects, both on a theoretical and on a practical level. Therefore, the book opens with an in-depth literature review that frames the aging phenomenon through an interdisciplinary prism (first chapter, *Ageing Societies and Technological Innovation*). From unfolding concepts such as Ageing Society and Old Age, Jarke outlines the intimate relationship between ageing identities as socio-cultural constructs and information technologies, and how they shape each other, underlining the performative power of technology design and use. In particular, the author's perspective considers ageing as "a material-discursive practice", adopting Karen Barad's perspective, and supporting the concept of "media generation" (Bolin 2017) in order to distinguish across generations – i.e. every generation grows up sharing experience through media that shape that particular generation in unique ways. Therefore, there is not a unique definition or meaning of ageing, because it is a phenomenon that depends on the context (as design is, as it will be shown in the project chapters). Among the policy responses to ageing societies, the author focuses her work on the World Health Organization initiative "Age-friendly cities and communities". Jarke depicts the complexity of digitalization under different aspects, underling that the WHO model does not address technology enough to support people's later life.

In the second chapter, *Co-creating Digital Public Services,* the author articulates her proposal to fill the gap in an ideal inclusive process of digital transformation: through co-design. In fact, if social inclusion is also a matter of digital inclusion, in order to achieve digital inclusion, a design process needs to allow digital participation. The design approaches to do this vary, and Jarke outlines them using Arnstein's notorious *Ladder for Participation* essay to explain the different types of participation and how they are translated into design approaches, such as system design, user-centred design, co-design and participatory design. The author also shows how in the design history of digital public services, the tendency to move from an "administration centric" to a "customer-driven" approach should become predominant. Like in the first chapter, where she was pointing out the lack of involvement of older adults in the design of technologies, in this chapter Jarke documents the lack of citizens involvement in the design of digital public services, standing for a more inclusive and democratic design.

Moving to the more "practical" chapters, the chapters from the third to the sixth are dedicated to three projects that were part of the MobileAge EU project. All the projects share common topics such as mapping, the use of municipality open data and building friendly neighborhoods. The first two projects described in the fourth and fifth chapters, *Co-creation in Practice I: Co-creating a Digital Neighbourhood Guide (Bremen Osterholz)* and Chapter 5 *Co-Creation in Practice II: Co-creating a Digital Walking Guide (Bremen Hemelingen)*, were conducted by the author and her research group, in Bremen (Germany). Instead, the third project based in Zaragoza (Spain) and described in the sixth chapter, *Co-creation in*

Practice III: Co-creating Ageing-Friendly Routes (Zaragoza) has been included by the author for its comparative interest, even though she did not conduct the project, but participated to its planning and evaluation.

Jarke's book examines the MobileAge EU project under three aspects of analysis, evaluation and comparison: the politics of participation (which actors participate in the projects and how), sharing expertise (initial users become co-creators), enabling change (on a personal, social and digital level). These aspects highlight how power dynamics and interdependencies between stakeholders play in design processes, and need to be taken carefully into consideration when planning a co-design process.

In conclusion, this book is for those who have just begun research in the field of design, ageing and technology and look for a good companion to navigate the state of art and to study examples of well-tailored co-design projects. In fact, the first two chapters offer a robust theoretical frame of the main research and design issues in this field, while the following ones provide extensive descriptions of projects the author was involved in. Similarly, this book is a precious resource also for senior researchers and co-design practitioners, since the projects accounts (from the third to the sixth chapter), that constitute the main body of the book, offer in-depth details of the design processes that STS researchers, designers, stakeholders, computer scientists, can find informative and inspiring.

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Sacha Loeve and Bernadette Bensaude-Vincent

Carbone. Ses Vies, ses œuvres [Carbon. Its lives, its works], Paris, Seuil, 2018, pp. 342

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Using charcoal to draw abstract forms that emanate energy, brightness, materiality, and blackness, in the paintings of Korean artist Lee Bae, carbon black acquires different forms and meanings. Quite literally, it is a pigment made of soot obtained from burning plants or a chunk of carbonized wood assembled in massive black and chalky sculptures (Serafin 2019). Yet charcoal goes beyond materiality. The artist uses it as a metaphor for spirituality, purity, and essence as, in the Korean tradition, carbon is a powerful source of metaphysical experience. It is a material that intimately connects to life and time, and their transformation.

In the fascinating and highly informative book *Carbone*, Sacha Loeve and Bernadette Bensaude-Vincent offer a portrait of carbon that merges together all these different facets. Carbon is a technoscientific object that falls outside the boundaries of one history, definition, or scientific discourse.

If some carbon might develop into exhaustible forms like coal and oil, other forms remain unlimited, as by mass carbon is among the most abundant elements in the universe. So how can we explain its different modes of existence? What narration should we prioritize to account for the many ways carbon, its properties, and reactions can be studied, anticipated, and experienced?

Carbon is certainly more than a chemical element. The authors insist on the multiplicity of its signatures and heteronyms which are explored in great detail and with a persuasive writing. "Multiplicity" is used to convey an understanding of carbon as a quasi-object that redefines, to put it with Michel Serres, its status based on the connections it creates with the context.

Carbone joins a number of recent books attempting to consider the different identities of the element. Dag Olav Hessen's book *The Many Lives of Carbon* (2018) and Robert Hazen's *Symphony C* (2019) are two examples of the growing interest in recounting the history of carbon beyond the realm of chemistry. Like these accounts, in *Carbone* the substance is released from its status as a chemical element and becomes a milestone of the anthroposphere and its relation to the Earth. Yet Loeve and Bensaude-Vincent seem to provide an even larger perspective, which draws inspirations from the history of science and technology, STS, cultural studies, and philosophy.

The book is divided into three sections focused on the *invention*, *civi-*

lization, and *temporalities* of carbon. The first section looks at carbon primarily through the history and ideas of the natural sciences. The different understandings of carbon are always situated, emerging from a mixture of social, cultural, scientific, and economic conditions that characterized western societies from the early modern period through modernity. In the second and third sections, carbon abandons its disciplinary cradle to become the main protagonist of human history. The authors claim that the evolution of human culture is indeed marked by the effort to domesticate and inscribe carbon in everyday life, from the mastery of fire to coal mining, and the mechanization of labor to current policies to reduce Co2 emissions in the atmosphere. As a matter of fact, carbon has both shaped human welfare and now mockingly exposes it to risks that are unprecedented in history. Rising concentrations of carbon dioxide are the principal cause of climate change and, therefore, a primary public enemy in the fight for a sustainable future. At the same time, carbon acts as a currency and a credit equivalent to a given amount of emissions, and thus performs a fundamental role in the financial market.

Taken collectively, all of these signatures show carbon's ability to cross disparate realms of knowledge, from science and technology to politics, economy, design, and culture. Living and inert, natural and cultural, carbon acts as a kaleidoscopic object with an intimately hybrid nature, one manifested in its power to acquire as many forms as the periods of punctuated evolution of our societies.

Following this evolution, the authors reached as far back as Virgil's *Aeneid,* where the mephitic air of the Mefite di Rocca San Felice in central Italy was deemed toxic. Gaseous exhalations of carbon dioxide and sulfuric acid wafting from the fumaroles caused the vegetation to perish and were regarded by the inhabitants of that region as lethal for human beings. Loeve and Bensaude-Vincent emphasize how carbon – already in such a distant past – was deeply inscribed in popular culture and collective memory as an element closely associated with risk and peril. This "geomythological" (p. 23) narrative persists in some of the later conceptualizations and scientific studies of carbon as, for example, toxic air, gas, and ultimately Co2.

Throughout the sixteenth, seventeenth, and eighteenth centuries, carbon became a primary object of interest for a rich generation of natural scientists and philosophers, especially in Europe. Robert Boyle, Joseph Priestly, Antoine Lavoisier, and Henry Cavendish sought to discover the real nature of carbon, investigating the products of its reactions and its many properties and forms, and ultimately tried to establish an exhaustive nomenclature. In the nineteenth century, Dmitry Mendeleev used carbon to express the material identity of a chemical element that remains invariant as a standard measure notwithstanding its possible conversions. Carbon embodied a combination of materiality and abstraction, turning into a metaphysical substance that, following Mendeleev, became an exemplary

illustration of what the term "element" means in his periodic table. But, as the authors point out, carbon would soon "emancipate" (p. 63) itself from chemistry to become the principal *fuel* of human civilization. Carbon fossil – the backbone of life accumulated in the Earth's crust due to photosynthesis – intermeshes geological time with human temporalities when burned and dispersed in the air. It ignited the industrial revolution, and favored a political and economic system that profited from subordinate labor (Malm 2016). The carbon-based development of our society and the accumulation of capital are two complementary processes which reveal how "techno-optimism" and the exploitation of fossil fuels have led to both resource scarcity and social inequality.

Although the authors dwell upon carbon fossil in the second half of the book, it feels that the history of carbon does not tell us that much about the history of coal. With many "modes of existence" and its own role in our economic systems, coal is not reducible to carbon but might instead require its own biography, which surely goes beyond the scope of this book. However, the multiple systems of knowledge tracked by Loeve and Bensaude-Vincent offer a very erudite picture of carbon as an agent of history, and guide the reader through stories that interweave human culture, natural history, and cosmic processes. The authors feel the urgency of delivering as many ontologies of carbon as possible, and this makes a case for what they term "ontography" (p. 284). Carbon is indeed mobilized in its role as graphite that writes its own histories – as on Lee Bae's canvas, where carbon black is the author of its shapes. Far from indicating a metaphysics of the object, ontography is not a synonym for ontology. Instead, it is a narrative that draws the combination of ontology and biography in its making. In other words, it is a process of writing (*écriture*) of ontologies. Drawing on Gilles Deleuze, the authors emphasize the role of ontography as a disposition of ontologies.

Ontography is also used as a synonym for plurality. It gives a voice to the many lives of carbon. In this respect, carbon suggests both ontological and epistemological pluralism as the diversity of modes of existence of carbon invites for tolerance among the different forms of knowledge. Hence, following Bruno Latour and Étienne Souriau, showing the plurality of carbon would discard totalizing forms of knowledge and deconstruct dominant narratives.

Despite the different yet intertwined lives of carbon assembled in the book, we never feel a sense of disorientation. Some readers may still wish for a privileged perspective to emerge. Such a red thread, more openly framing the authors' purpose and position, would be especially valuable in a moment in which a proliferation of post-histories, -truths, and -humanisms often swells into a postmodern relativism and individual systems of values. A privileged angle would not necessarily come across as reductionist or imposing a dominant narrative. It can be a vision, a claim or a belief that many people could share and adhere to, generating a sort of collective

awareness. One may start from the assumption of carbon as a *marker*, namely an indicator, or evidence that designates the most profound transitions in our social, ecological, and geological history, and then trace back carbon's career in light of this fundamental assumption. The current disruption of carbon cycle, for example, is a global biogeochemical marker of the Anthropocene, a term describing a proposed geological epoch characterized by the all-encompassing influence of human systems on Earth's ecology and geology. Fly ashes are another set of markers that derive from combustions processes, which leave their mark in strata and are measured as material sediments of the Anthropocene. Plastic, a carbon-based material, is another anthropogenic marker that is relevant for understanding the Earth under human pressure. Against this backdrop, as a marker, carbon is not only an agent of human history, but an agent of Earth system history under human influence.

The question of the Anthropocene is certainly not overlooked by the authors. It comes towards the end of the book in a section addressing how the age of carbon influences the Earth's temporalities. The authors approach the question by referring to a *récit* (p. 263) that has at times generated techno-aesthetically mediated and sublime experiences of nature where "man" is placed at the center of the Earth and dominate the planet. According to the authors, verticality and linearity are the privileged dimensions of the Anthropocene that are rooted in geological culture. On the contrary, they argue that carbon would, also in this case, invite to consider the multiple temporalities that fall outside narrow geochronological definitions.

In this context, it is worth mentioning that current interdisciplinary discussion on the Anthropocene points out to the need of defining the proposed new geological epoch from a perspective that interlaces the study of the Earth system with that of human phenomena and their different timescales. This investigation requires an effort that goes well beyond assessing "verticality" as the only dimension of the Anthropocene and draws instead on a plurality of methods and approaches expanding beyond the earth sciences. Also importantly, recent attempts to discuss knowledge in the Anthropocene show how the concept has acted as a powerful tool not only for rethinking human history, but also for fostering new research directions in which the (earth and environmental) sciences, the humanities, and the arts can cooperate to experiment with new ways of producing knowledge to cope with the global environmental crisis (Renn 2020). In this respect, adopting a perspective from energy history or Earth System Science could help reinforce existing links between carbon's different modes of existence and the current Anthropocene predicament. By focusing so meticulously on the heteronomies of carbon, the authors are left with little space to elaborate on an even more expanded history that would include the prospect of the future in human-carbon interaction. But what *Carbone* achieves is

already extremely rich, persuasive, solid, and driven by gargantuan research work. It bears witness to the authors' remarkable ability to deal with the extraordinarily inexhaustible subject of carbon, one which still leaves much to be said, as Lee Bae's charcoal reminds us.

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Felix Tréguer

L'Utopie déchue. Une contre-histoire d'Internet, XVe-XXIe siècle. [The Fallen Utopia. A Counter-History of the Internet, from the 15th to the 21st Century], Paris, Fayard, 2019, pp. 350

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A few decades ago, the Internet was heralded by many as a new frontier, a promised land where freedom would reign. It would bring the world together in a global village, end conflicts, and challenge monopolies of old. Today, the Internet has become almost frightening, and definitely highly contentious. For example, end-to-end encryption has become more and more widely accessible, but it regularly comes under attack by law enforcement and intelligence agencies. Social media are accused of depriving their users from their privacy and of facilitating the spread of dangerous "fake news" and terrorist propaganda, fuelling calls for "content moderation" mechanisms that amount to a restoration of censorship under a new name.

These debates all seem rather new because the technology at play is new. *L'utopie déchue* (in English: *The Fallen Utopia*), a book derived from the author's doctoral dissertation in political science, thus surprises us with its subtitle: *Une contre-histoire d'Internet, XVe-XXIe siècle* (in English: *A*

Counter-History of the Internet from the 15th to the 21st Century). By announcing from the onset that it is going to narrate the History of the Internet from the 15th century onwards, this book reminds us that debates that are framed as being about the Internet as a technology are actually the continuation of a much older discussion on the level of freedom that should be afforded to the public sphere, defined as the socio-technical assemblage (or *dispositif*) through which members of a society discuss political matters. This debate has been ongoing for centuries, and predates both computers and the Internet.

Félix Tréguer, the author, is now a post-doctoral research fellow at the Centre de recherches internationales at Sciences Po Paris, and is also affiliated to the newly created Centre Internet et Société of the CNRS.He is also known for his involvement in La Quadrature du Net, an NGO he is a founding member of, which advocates for the protection of human rights on the Internet. This NGO has close historical ties to the free software movement.

L'Utopie déchue is a title that reflects a feeling of disillusion felt by many activists close to the hacker and the free software culture. It is divided in four sections, and fourteen chapters, not including the introduction and the conclusion.

While digital utopias born in the 1970's brought an immense enthusiasm to the idea that computers could become a tool for emancipation, many are beginning to question these beliefs in light of the development of the platform economy, digital labour exploitation, pervasive surveillance, algorithmic control and the establishment of enclosures controlled by global tech corporations. What went wrong?

To answer this question, section 1 of the book, "Genèse (XV^{e}-XX^{e} siècle)" (in English: "Genesis 15th-20th Century") starts off by reminding readers of the link between surveillance, censorship and the census, which were all the responsibility of two elected officials called censors in the Roman Republic. He then tells the tale of a century-old struggle between the state's tendency to establish control over the public sphere, and attempts to subvert it. When the printing press allowed the spread of new ideas, monarchies across Europe drew from new theories on sovereignty and the "*raison d'État*" (in English: state interest) to invent new modes of surveillance and censorship of the public sphere. This same scenario played out at the invention of the radio, when states struggled to contain the expansion of amateur and privately-owned radio stations. By the mid-20th Century, liberal democracies, while guaranteeing freedom of speech, provided fertile ground for corporate control aligned with state interests over the public sphere.

In section 2, called "Informatisation (1930 - 1980) (in English: "Digitisation (1930 - 1980)"), the author recounts the invention of computers and of the Internet. In the next section 3, called "Subversion (1980 – 2001)", he tells how computers, first seen as the ultimate artefact of industrial social

control embodied by the corporate culture and image of IBM, turned into a promise of emancipation and of a free, democratic and borderless public sphere freed from the influence of the state and from mass media oligopoly. This new utopia is described as having also led to many practical realisations, like the personal computer or the World Wide Web. These practical realisations heralded a new era of freedom and challenged the gate-keeping powers of an oligopolistic cultural and media industry. They threatened the equilibrium between freedom of expression and control of the previous era, and section 4, called "Reféodalisation (1990 – 2020)" (in English: "Reverting to feudalism (1990 – 2020)" describes how a strong response from states has led to what Félix Tréguer, quoting Shoshana Zuboff (2018), describes as surveillance capitalism: a system which tends towards total surveillance and where humanity, translated into data, becomes the subject of capitalistic accumulation.

Throughout his book, he talks from a Foucaldian perspective where the "state" is not so much an institution as a type of governing rationality where power is not centralised but may be distributed across a variety of actors (see: Foucault, 1998 [1976]). The level of entanglement between private and public in Internet Governance, especially surveillance, makes this approach relevant. It is also unspecific enough that it can be applied to several eras through which the actual institutional setups of states have greatly evolved. The main shortcoming of this book is that this conception of the state at times tends to lack sociological finesse. It does not matter, however, as the aim of *L'Utopie Déchue* is not to provide an in-depth socio-political analysis of specific public policies in a given domain of state intervention. Instead, it situates contemporary debates on Internet governance, online censorship and surveillance into a long-term account of a centuries-old struggle, that has remained defined by the same fundamental divides despite, or maybe regardless of the evolution of the technical elements that co-constitute a public sphere it defines as a socio-technical *dispositif*. Seen from this angle, censorship and surveillance are two sides of a same coin. And although they are exercised on and through socio-technical means, Félix Tréguer convincingly shows that the topic of contention is not the computer or the Internet (or any other artefact) as such, but the politics of public speech, human rights and the relationship between citizens and the state.

Yet in the concluding chapter of the book, Félix Tréguer leads his reader through a sharp turn to the infrastructure, and ends up questioning the very existence of computers on political grounds. He argues that maybe these *should* become the topic of contention as such. The very title of this concluding chapter, "Arrêter la machine?" (in English: "Should we stop the machine"), sounds like a provocation. Current decision-makers are committed to growth through perpetual, preferably permissionless, innovation.Even privacy advocates who defended the General Data Protection Regulation (GDPR) usually presented their demands as a way to build

"trust" in the digital economy, not as a means to stop the construction of such an economy or at least forbid some of its potential innovations. For many years, policy and even scholarly discussions on topics such as digital copyright, dataveillance or informational privacy has been focusing on regulating the *use* of technology through various legal, political and market constraints and incentives. What Félix Tréguer tells us is that this is important, but perhaps not sufficient, and that this insufficiency could explain the failure of activists to effectively challenge the power structures of surveillance capitalism.

L'Utopie déchue ends on a reference to the work of Jacques Ellul, who was an influential political philosopher and sociologist, as well as a protestant theologian, who has published many books offering a critical analysis of what he dubbed the "technological society." Arthur Miller's *Assault on Privacy*, which was quite influential in the early debates that led to the adoption of contemporary privacy and data protection legislation, was published in 1971. It opened with a long quote of Jacques Ellul's *Technology Society*, followed by a socio-political analysis of computers in society, a discussion of the right to privacy as part of a strategy to mitigate harmful effects of information technology, before concluding on yet another quote of Jacques Ellul.

In 1964, Lewis Mumford had written about the opposition between "authoritarian" and "democratic" techniques. Ivan Illich published *Tools for Conviviality* in 1973, quoted by Félix Tréguer in his book, which pleaded for a radical change in the theory and practice of human technology. These normative and moral reflections on technology were not just philosophical discourses limited to a restricted audience of contemplative thinkers, but made their way into practice, and influenced the movement in favour of personal computers in the 1970's and 1980's, as those were seen as a way to steer away from authoritarian computing (embodied by companies like IBM) towards a more democratic system. They were also influential in the shaping of public decision-making. Since then, however, there has been an intellectual shift from attempting to regulate artefacts, to regulating their uses.

Science and Technology Studies (STS) have been studying the role of socio-technical controversies in the social construction of technology for a long time. This approach has led, in the field of Internet Governance studies, to a "turn to the infrastructure" in which sociologists and political scientists study the material layers of the Internet to unbind the relationships between the material, the technical, and the political (Musiani et al. 2016). Such studies usually take a non-normative approach.

Félix Tréguer's concluding interrogation, coming from the field of political science, is more radical because it is the product of engaged action-research by someone who has long been a prominent human rights activist. It calls for more than mere legal or even technical patches on a digital socio-technical ensemble of networked computers that may be fundamentally

authoritarian in nature. This is why he speaks about a need to "stop the machine" (p. 308). In questioning whether we should accept the existence of computers, in a way, he appears to suggest that the problem would be solved if we got rid of computers. By doing so, it could be argued that Félix Tréguer falls into the trap of some kind of reverse technological solutionism (Morozov 2014). His provocative suggestion, however, should rather be understood as a call to reflect, and to make us look once more at technology itself, not only its uses or its controversies, through a moral and political lens.

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Julia Watson
Lo-TEK. Design by Radical Indigenism, Köln, Taschen, 2019, pp. 417

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The wetlands of my home town Bogotá (or *humedales* as they are called in Spanish) are one of the most biodiverse ecosystems of the city and its surrounding plateau. Today they are at the center of many development pressures and controversies, as well as numerous conservation efforts. From politicians, urbanists, designers, to activists, almost everybody has an opinion about how these patches of "nature" should be either preserved or dried out in the name of progress. However, few have said about how we could work with the wetlands to thrive together. In contrast, research efforts in the recent decades have uncovered that these wetlands are not just the outcomes of the particular natural ecological conditions of the area,

but importantly that their existence is also a product of the intentional stewardship – and later abandonment – of a complex agro-hydraulic landscape of *camellones* (in English: ridges) tended by local Indigenous groups over millennia (Rodríguez Gallo 2019). This system supported a highly diverse, resilient and rich way of life until the Spanish conquest and further colonization erased, through genocide and ontological occupation of territories and ways of living, the very practices and knowledge that maintained that landscape. All we have left are traces of that landscape as seen from old aerial photographs and from the many indigenous water-related words inscribed in the topography of the area (Rodríguez Gallo 2019).

Julia Watson's Lo-TEK: Design by Radical Indigenism is a highly visual, detailed compilation of more than 100 similarly sophisticated indigenous landscapes and their related infrastructures from around the world. Unlike the vestiges of the ancient *camellones* in the plateau of Bogotá, all examples catalogued in the book continue to support indigenous peoples' everyday lives today. Through their tending and maintenance of these infrastructures, indigenous people contribute to the larger wellbeing of the ecosystems themselves. In the book, this wide variety of human-nature symbiotic infrastructures is reframed as Lo-TEK, that is "sustainable, adaptable, and resilient technologies that are borne out of necessity (p. 21)"; placed in contrast to what are often referred as Lo-Tech, that is "simple, unsophisticated, uncomplicated and primitive technology" (p. 20). Her book has the explicit aim to create a design movement that can help us – though there is very limited explanation about who "us" might be – rebuild an understanding of both indigenous philosophy and vernacular architecture, which as she argues, already generate sustainable climate-resilient infrastructures. To aid in this movement building task, in the book, the author proposes various resources organized in three parts.

First, a very broad outline for a new mythology of technology partly inspired by the methodology of radical indigenism as defined by Eva Maria Garroutte (2018) that is combined with a handful of other eclectic concepts such as cultural keystone species. The second part contains a basic lexicon that is assembled and then identified, and highlighted throughout the examples in the next section of the book. The last section is the compendium of examples proper, concretizing some of the possibilities of Lo-TEK by describing, in accessible terms, how for example the ingenious boma acacia corrals of the Maasai, the polyculture milpa forest gardens of the Mayans or the wastewater treatment system developed by the Bengalese in Kolkata emerged and are kept alive. The exemplars in this section are divided by the particular ecosystem within which they work, namely: mountains, forests, deserts, and wetlands. The exemplars are fleshed out through various strategies – for example, descriptive narratives that locate these technologies within their larger cultural context, the sourcing and curating of a large body of photographs, and the creation of a series of compelling architectonic and visualizing devices that document particular

details of their configurations. I consider this section the most vital contribution of the book, and would hope they continue developing. One possible direction for further development is to address the critical need to find non-verbal forms to communicate out not only technical details, but also the relations, ontologies and the forms of governance that make these configurations of people, place, non-humans and stories, possible (see: Haraway 2013). These aspects remain under addressed in the analysis and visual representations in the book. However, there are interesting seeds found in the book to further the "drawing things together" that Latour (2008) once invited designers to explore further. I also found that the lexicon section would merit expansion. More than providing pointers to further reading and examples hinting to how these terms might manifest, it could offer more in-depth explanations and explicit links to think through and communicate collectively; so that important concepts such as "radical indigenism" can be actually applied and mobilized to build the movement.

Many of the issues raised by the book will be familiar to STS scholars, although STS scholarship is not the book's main audiences. The author's narrative and each of the examples in the compendium, draws our attention to the socio-technical character of all technology and the preeminence of infrastructure in contemporary understanding of the world (Star 1999), something discussed extensively in STS, albeit from a different angle. Also, its continuous attempts to reframe what counts as technology and innovation will resonate – and contrast – with feminist STS research agendas that invite us to look critically at innovation (see: e.g., Suchman and Libby 2000) by paying close attention to forms of care (Puig de la Bellacasa 2017), repair and maintenance without privileging preoccupations with the "new".

In general, the book offers an accessible and important testimony of the complex, plural and rich knowledge and practice systems that exist today. I, however, remain curious to learn more about how indigenous communities themselves (and not only unidentified us) could also use these resources to continue repairing and tending to their worlds, and reconfiguring their own ecological knowledge. It seems to me that their ability to mobilize their own knowledge, and not the fact that we (designers or STS scholars) are able to do so, is particularly urgent. As the compilation makes it also painfully obvious, most of these Lo-TEK are under enormous encroaching pressures, putting them at risk of following the steps of the *camellones*, which once supported a unique way of life in the place I call home.

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Essays

Crossing Boundariers

Scenarios

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