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Radical reflexivity, experimental ontology and RRI

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ABSTRACT

RRI does not challenge what this paper calls 'lyseology': mobilizing science to convince policy makers and the public that the present possesses some form of lack that should be addressed with a new technology. For a sustained critique of technological fixes as solutions a more radical shift from the persistent old view of a static outside world is required. This entails a process-based understanding of reality and specific consequences thereof for practice. To do so the paper offers an analysis of in what manner current RRI discourse builds on old subject-object ontologies and relies on an outdated worldview. The paper suggests possible pathways of conceiving of research and innovation otherwise: RRI should reorient towards the ontology turn, learn from ethnomethodology and radical reflexivity, as well as from the politics of material participation. This paper proposes that research and innovation should engage with quantum theory inspired alternative worldviews.

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Introduction

Current crises related to the legitimation of research and innovation (R&I) or the social impacts of technology, such as the climate emergency (Nissen and Cretney 2022), intensified global inequalities (Harvey 2022), and the emergence of new types of political illiberalisms (Glasius and Michaelsen 2018) revolve around, *inter alia*, questions of technoscience (Braun and Randell 2023; Mejlgaard et al. 2018b). The dominant current narrative of technology relies on a deficit worldview, wherein there is a world 'out there' to be filled with technosocial objects as the present is perceived as imperfect and deficient (Dewandre 2018). However, this imperfection is assumed to be rectifiable through the unending task of techno-political solutionism (Morozov 2013). It is a worldview in which it is anticipated that the future can be controlled by humanized technology, provided we possess adequate knowledge and have the means to bring that future into being.

The challenge engineers and policy makers are presumed to face is to convince 'the public' of what they themselves are already convinced of: better and more humane

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technology is the panacea to the crises (Wynne 1995). Current examples abound: electric or autonomous vehicles are suggested to 'solve' sustainability or safety issues (Braun and Randell 2020); fracking will 'solve' gas and oil shortage (Howell et al. 2019); xenotransplantation will offer unlimited supply of organs for transplantation (Griessler 2012) to name a few technoscientific controversies discussed in the literature.

This is 'lyseology'[1]: mobilizing science to convince policy makers and the general public that the present possesses some form of lack that should be addressed with a new technology brought to life and offered as solution. Discussing and researching safety in automobility leads to the 'driver problem' and a lack of faultless decision making and control that autonomous cars will solve (Braun and Randell 2020). Researching emissions leads to the 'propellent problem' and the lack of emission-free mobility that electric cars will solve (Wentland 2016). Lyseology generates lack in the present suggesting that it is in the future, populated by new not yet existing engineered artifacts, that a better, lack-free world is believed to lie. What follows is that emergencies can and should be dealt with by stronger focus on and push for research and innovation (R&I), and develop 'smart', 'digital', 'datafied', 'green' and 'autonomous' techno-offerings, such as those proposed in and by the 'Green Deal' for instance (Dalton et al. 2020). These names sanitize and legitimize technologies under their semiotic umbrella (Sadowski and Bendor 2019).

The lyseologist worldview of R&I has proven to be resilient to theoretical and political agendas that call for rethinking technological progress, power, and responsibility in R&I. Sustainability (McDonnell, Abelvik-Lawson, and Short 2020), corporate social responsibility (CSR) (Braun 2019; Ehrnström-Fuentes and Böhm 2023), and traditional criticism of the politics of technology (Jasanoff and Kim 2015; Winner 1986) have been incorporated into hegemonies of corporate power, providing support for the push for more solutionist determinations. Originally developed as critical agendas and alternative forms of policy praxis, instead of offering socio-political sustainability pathways they have been transformed into sustaining narratives for climate impacts or global neoliberal capitalism.

The main ambition of this paper is to suggest that for a sustained critique of hegemonies of corporate power and technological fixes as solutions a more radical shift from the persistent old view of a static outside world is required. Policy is also to be rethought in terms of critical lyseology. Policy agendas and practices may not (only) produce frameworks for (ethical, responsible) implementation but assist in questioning the conditions and processes that constitute lyseology as the solely intelligible possibility.

This entails a move towards a process-based understanding of reality and specific consequences thereof for practice, including Responsible Research and Innovation (RRI). To do so, this paper offers a detailed analysis of in what manner current RRI discourse and its policy applications build on outdated subject-object ontologies and rely on an old-fashioned and simplified worldview. I will suggest to kickstart a discussion about possible pathways conceiving of R&I otherwise.

The paper is structured as follows. I will start with discussing recent developments in Science and Technology studies (STS) before offering an overview of developments, definitions, ambitions of RRI together with a somewhat alternative reading of its history. I will argue that much of the conceptual and political fragility of RRI, discussed in the critical RRI literature, is due to a loss of a more radical form of reflexivity that it

promised to offer R&I. I will then turn to the politics of RRI and argue that a robust philosophy informing the politics of responsibility and a more democratic R&I polity should be methodologically situated within the turn to ontology in STS. To open the debate towards an ontological otherwise, and to raise unnerving ontological and epistemological questions to instigate radical change in these beliefs as well as in policy I will turn to approaches grounded in radically different ontologies: those of radical reflexivity, material participation in democracy, and quantum theory. These concepts require different analytic tools to address the moral and political order of research and innovation – those of ethnomethodology and more-than-human politics that call lyseology into question. The concluding remarks will summarize the arguments presented and suggest new avenues for research on reviving RRI.

The ontology turn in STS

Science and Technology studies are complex, multidisciplinary, and policy-oriented endeavor with an equally complex history (Sismondo 2004). It incorporates sociology and ethnography of science and technology (Bauchspies, Croissant, and Restiv 2006), feminist and intersectionality orientations (Åsberg and Lykke 2010; Hamilton 2016), as well as more philosophical perspectives towards post-phenomenology (Ihde 2009) or quantum technoscience (Barad 2007). The dense history includes strands that ontologize technology, human experience and performative action (Law and Lien 2018) as well as a more practical view that inspires and supports science and innovation policy (Warnke and Heimeriks 2008). To recap the entirety of the story of STS from its philosophical pre-history to its current manifold directions is beyond the scope of this paper. What amalgamates the different strands is the claim that all science and technology is (socially) constructed, suggesting that our (social) world and technologies therein 'could be otherwise' but aren't due to historical, social, cultural or ontological factors, as well as an ambition to understand what makes technology 'stabilize' into the form we come to recognize as our technosocial world (Jasanoff and Kim 2015).

A turn to ontology has characterized a specific strand in STS since the early 1990s. This turn was not taking up the baton of discussions on and about Being in metaphysics or in philosophy in general, but rather exemplified a strand of scholarship that focused on what came to be referred to as 'practical ontology' (Gad, Jensen, and Winthereik 2019): an emphasis on ontology as an empirical phenomenon (Woolgar and Lezaun 2013). The turn to ontology begun with the constructivism-realism debate in the beginning of the 1990s (cf. Cetina 1993; Sismondo 1993a, 1993b) arguing that

> a strong constructivist thesis, with respect to ontology, is one that shows how *the world is slowly moulded into shape* in ever new ways through successive generations of (scientific) practice […] and felicitously performs the reformulation of recurrent questions, the felicity condition being that reconstruction leads to new enquiries and fresh food for thought. (Cetina 1993, 560 my emphasis)

Others have focused on science and its use of technoscience (Ihde 2009) in instrumentalization and classification, establishing relations of heterogeneity and stability in scientific practice with the use of 'elevator words' and constructing new entities and kinds, such as the 'Child Viewer' (Hacking 1999).

As worlds or *onton*[2] perform themselves into being (Braun and Randell 2023), ontologies (that is, discourse and reflection on onton) are seen not as schemes of classification but embodied, enacted or performed practices involving humans and non-humans in entangled networks inscribed into reality (Law and Urry 2004). Accounting for how an ontology has been constituted, reproduced, and enacted requires attending to what may be called 'ontology work' (Braun and Randell 2023). Ontology work is manifold: the 'ontography' of the ethnomethodologists describe the ontology as it is constructed by science (Lynch 2013), while the mundane ontography of the every(wo)man and the everyobject inscribes the world by relational, entangled, discursive material practices (Law and Urry 2004; Mol 2021). Both are work that is directed to the construction and reproduction of a world – an ontology.

It is the ontology work that is routinely performed by human and non-human agents engaged in the continual work of creating and sustaining our everyday world. Citing Percy Bissche Shelley's reflections on poets as 'the unacknowledged legislators of the world,' it is the work of those, as Carl Mitcham (2014, 19) has put it, who 'by designing and constructing new structures, processes, and products . . . [influence] how we live as much as any laws enacted by politicians'. A contemporary example of what I mean by ontology work is what Ann Cavoukian calls 'privacy engineering': performing the boundary fusion of 'law, legal rights and technology as positioned on the same ontological level' (Rommetveit and van Dijk 2022, 856). It is 'characterized by proactive rather than reactive measures. It anticipates and prevents privacy invasive events *before* they happen … .[I]t comes before-the-fact, not after' (Cavoukian 2009, 2).

STS debates about the politics of reality construction and the politics of (disciplinary) knowledge show, as Heur, Leydesdorff, and Wyatt (2012) demonstrate in their bibliometric analysis of the turn to ontology in STS, 'how objects and issues are constructed and categorized, possibilities for interventions and transformation become visible'. As they argue '[n]ot only things, but also ontologies could be otherwise' (357).

Specific scientific methods which comprise particular instrumental, technical, and human configurations are used to construct realities and assertions about the world and its materialities (Garfinkel, Lynch, and Livingston 1981; Latour 2000). Crafting implies more than just human action and talent: making as a process involves people, machines, traces, resources of all kinds, and potentially spirits, angels, or muses (Law and Urry 2004). This suggests that the world is manifold and that it is created through a variety of contentious social and material relations (Law 2015). By taking into account this ontological diversity differences are not reduced to cultural or epistemological viewpoints *on* 'the world'.

Instead, the ontopolitical shift enables to map various situated practices that represent various ontologies – of bodies, of kinds, or of networks, to name a few. The body and its diseases are multiple depending on where and how they are enacted, discussed, measured, and observed (Mol 1999). Same goes for long distance political control in the case of colonies in the seventeenth century: depending on their situatedness, things and humans become entangled in multiple networks that extend their politics over space and over time (Law 1986).

RRI and its critique

Responsible research and innovation (RRI), a policy-oriented framework explicitly addressing ways to rethink accountability and responsibility in R&I, has acquired

relevance in discussions on European research and innovation policy and funding, particularly during the development of the 'Horizon 2020' framework (Griessler et al. 2022). The concept relied on research on anticipatory governance, technology assessment, and ethical, legal, and social aspects (ELSA). The definition of RRI that is frequently used is that it is

> a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability, and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society). (Von Schomberg 2013)

As Griessler et al. (2022) argue, this definition attempted to accommodate the tension between the ethical origins of RRI and the predominant innovation paradigm that perceives R&I as an engine for jobs and economic growth.

More procedurally and theoretically inclined researchers have suggested a wider, more inclusive definition where '[r]esponsible innovation means taking care of the future through collective stewardship of science and innovation in the present' (Stilgoe, Owen, and Macnaghten 2013, 1570). They offered four key features of a procedural view of RRI – anticipation, reflexivity, inclusivity, and responsiveness – that come from public discourse about science and technology. Proponents of RRI within the EC attempted to reconcile disagreements about RRI by trying to place RRI within the context of the engine for economic growth, linking RRI with existing EC funding traditions, and taking up criticism from the academic responsible innovation community by borrowing some of their theoretically grounded ideas, such as anticipation and reflection. This resulted in creating a down to earth policy translation of the framework by the European Commission that had proposed six areas of activity for all RRI programs as fundamental for operationalizing the concept: engagement, ethics, gender equality, open access, science education, and governance. However, debate and the series of compromises by different actors in and outside of the EC made RRI a financially, legally, institutionally and conceptually fragile policy concept (Griessler et al. 2022).

Proposed frameworks have been criticized for interpretive flexibility as well as the term's vagueness. A typical complaint about RRI is that neither its definition, nor its implementation are well understood by relevant publics that would have needed to apply, fund, or implement it (Braun et al. 2023; Novitzky et al. 2020). It was viewed as overly ambiguous because of the absence of standards and benchmarks (Mejlgaard et al. 2018a). Others challenge the framework's application in the real world and suggested further investigation as well as a move away from the narrow concentration on research and innovation activities in academic settings (Blok and Lemmens 2015).

While I agree with Owen et al. (2021) that 10 years on, much of the initial substance and ambition of RRI remains important, I suggest that there needs to be a reorientation of its theoretical underpinnings and empirical practices to deliver on its original promises. I will challenge the claim that RRI, as developed over the last decade, 'constitutes a robust philosophy [..] to help reflect on existing values, economic drivers, extant institutional logics and standing epistemic practices in different research and innovation contexts' (Tabarés et al. 2022, 314). I will also suggest that to collaboratively address the looming question of 'what kind of innovation, for what ends and for whom' as well as RRI to remain sites of debate, of praxis and of politics (Owen, von Schomberg, and

Macnaghten 2021, 17), a new mode of politicizing RRI – reflecting on and being attuned to the ontologically otherwise (Woolgar and Lezaun 2013) – must be enacted.

This realignment of both theory and praxis shall be done by reorienting RRI with recent developments in STS, specifically with the ontology turn and its politics of material participation (Marres 2015). In its present form RRI, addressed as ethically contained technological innovation primarily perceived from an economic perspective and with a certain naivety of its social and political ambitions and ethical presuppositions, is unattainable (Blok and Lemmens 2015).

Social science inquiry should assist policy makers to critically address lyseology. RRI could raise researchers' and practitioners' awareness that scientific and innovation work shapes and creates worlds not only technologies and artifacts 'therein'. Such awareness would make visible the politics of artifacts created based on the old view of a static outside world. Such politics demotes valuable inorganic and nonhuman life to be extracted, destroyed, or exploited for human efficacy.

STS, ontology work and RRI

The emergence of RRI is, of course, intimately intertwined with advances in STS research. RRI and STS have a shared genealogy of science, society, technology and policy studies reflecting on ethics, politics and society/technology confluence (Rip 2014; Winner 1986; Wynne 1995). Stilgoe, Owen, and Macnaghten (2013) argue that STS inspired conceptions of responsibility build on the understanding that science and technology are not only technically but also socially and politically constituted. They suggest that unforeseen social impacts of technology – potentially harmful, perhaps transformative – are not only possible but probable. RRI builds on controversies concerning the social and ethical responsibility of science, specifically on anticipatory governance and technology assessment (Owen and Pansera 2019). The procedural definition of RRI presented in the seminal paper (Stilgoe, Owen, and Macnaghten 2013) owes much to research in STS: anticipation relies on technology being formed by scientists' and innovators' 'imaginaries' of the future (Jasanoff and Kim 2009, 2015); reflexivity banks on ethnographic STS laboratory studies in the interventionist vein (Latour and Woolgar 2013; Mol 2014); inclusion reflects the STS problematization of public dialogue as public good (Wynne 1995); while responsiveness addresses the STS inspired societal embedding of technologies requiring a process of enrollment and highlighting how policy discourses shape the governance of emerging technologies (Latour 2005; Owen et al. 2021).

This said, the turn to ontology reflecting on the conditions of possibility in science, technology and social confluence as well as the 'strong constructivist' program of science and technology has been (partly) given up. Abdicating reflected the ambition of RRI to be accepted into the suburbs of technology assessment and the socio-economic analysis of innovation. RRI is suggested to be demoted from its original holistic vision to become a sheer 'policy artifact' (Owen and Pansera 2019) and argued to have more to do with bureaucracy than with its original conceptual foundations (Rip 2016). Put more colloquially and reflecting on the praxis of innovation: 'it became clear that the wish for (more) responsibility clashed with the realities of existing innovation processes' (Blok and Lemmens 2015, 31).

Blok and Lemmens ledger this as 'epistemic' (e.g. complexity, uncertainty and unpredictability of technology) and 'ethico-political' (conflicting worldviews, interests, value systems and imbalances of power). I suggest however, that this has more to do with the loss of radically questioning the 'ontological space' and the modes of how 'the world is slowly moulded into shape' by scientific as well as research and innovation practice than with the naïvite of RRI policy makers or practitioners about what innovation is all about.

Assessing RRI as a manifold fragile policy instrument Griessler et al. (2022) discuss policy change in terms of Sabatier's Advocacy Coalition Framework (Sabatier 1988). Sabatier posits that belief systems matter in policy change and uptake. These beliefs are organized into a hierarchical structure, with broader levels constraining more specific beliefs. At the broadest level, Sabatier argues, is the 'deep core' of the shared belief system. This includes basic ontological and normative beliefs, such as the perceived nature of humans or the relative valuation of individual freedom or social equality, which operate across virtually all policy domains. Next level beliefs, termed 'policy core' (value priorities: economic development vs. environmental protection or major societal problems and their principal causes) may involve empirical elements which change over time with the gradual accumulation of evidence.

Deep core beliefs are very resistant to change – akin to a religious conversion (cf. Husserl 1970) – while policy core beliefs are somewhat less rigidly held, therefore more open to change (Jenkins-Smith and Sabatier 1994, 180–181). The criticism of the workings of the advocacy (and opposition) coalitions in Griessler et al., as well as the more general criticism of RRI by others (Blok and Lemmens 2015; Novitzky et al. 2020; Owen et al. 2021; Owen, Bessant, and Heintz 2013; Owen, von Schomberg, and Macnaghten 2021; Rip 2014, 2016) focus on what Sabatier calls the 'policy core'. However, on a closer reading of their arguments, it is rather the 'deep core', that is the ontological and normative assumptions of prevalent beliefs about technology, society, science, innovation and the molding of the world that are incommensurable with the critical theoretical and practical ambitions of RRI to steer instrumental, technical, and human 'innovation' configurations (Griessler et al. 2022; Von Schomberg 2013).

The main thrust of a radical criticism of technology-society confluence has been lost. Radical criticism, as STS' turn to ontology has shown, is in the ontological reflection on the conditions of possibility, that is how the world and entities 'therein' are molded into being by the ontology work or ontography of theorists and practitioners of R&I. Put another way: both the naïvity about innovation and about the world is to be questioned.

The 'world' of research and innovation

The naïvity stems from leaving behind inquiries about the ontological otherwise in STS and signing up for the narrative of research and innovation as the story of modernist progress without questioning this narrative from its 'outer rims' (Pollner 1991). The 'world' is assumed to be a subject independent 'out there' which may be approached by the great divide between nature and culture/society (Escobar 2020), a colonialist difference between moderns and nonmoderns (Chandler 2018), and a unidirectional linear temporality that flows from past to future (Blaser 2013). This modernist worldview stems from the monotheistic religious tradition of Christianity with the idea of a single deity

imposing an order on the formless matter to create a single cosmos of inanimate objects and animate non-humans with a particular nature that is handed over to humans to control (Law and Lien 2018). It is embedded in the Enlightenment quest for certainty in an era of devastation after the schism between Catholics and Protestants within Christianity during the Thirty Years' War (Rommetveit et al. 2013; Toulmin 2013).

The idea of a separate nature and its controllability was carried over to the sciences: discovering laws, knowable modes, Galilean mathematics and Newtonian mechanics that could be turned into technologies by which the world can be disciplined and managed (Husserl 1970). A unilinear conception of time and space (Urry 2000) was institutionalized as imaginary (Braun and Randell 2022): a move toward increased industrialization, progress, material development and globalization (Escobar 2020). This has enabled the conversion of everything into a binary of the 'social' vs 'nature' and 'nature' into 'resources'; the treatment of the materiality in all areas of inorganic and non-human life as stuff to be extracted, destroyed, or exploited by economies of human utility (Escobar 2019). This capture is marked by multiple forms of violence (Böhm and Pascucci 2020; Nixon 2011; Shapiro and McNeish 2021), denying other 'worlds' or 'things' the possibility of existing on their own terms (Ehrnström-Fuentes and Böhm 2023).

As a philosophy RRI (and R&I in general) is a deeply modernist endeavor: professing a One-World World (OWW) (Law 2015) that is hegemonic, universalist and 'out-there'. Worlds are seen not as performed and relational but as a spatio-temporal 'other' in which humans and non-humans are contained. 'Reality' (the container-world) is reified and detached from the 'ontography' (reality inscription) that constantly re-enacts it (Braun and Randell 2023; Law and Lien 2018). Research and innovation are seen as machinations of socio-technical-material arrangements that create and insert artifacts *into* the world and are not seen as making that world by such machinations. A robust and radically reflexive philosophy of RRI reveals not only impacts on humans, their 'social' and 'natural' worlds, but reflects on and challenges the foundationalist social science ontology which, whatever the substantive claims, is grounded in a traditional modernist philosophy of science and metaphysics.

Following up on the criticism towards social reality and more traditional modes of social science inquiry the ontological turn in the social sciences (Escobar 2007) has aimed at decentering the reflective and knowing subject 'in here' from the world as a container of knowable objects 'out there'. Such ambition characterized strands of scholarship in science and technology studies (Latour 2005; Law 2009; Mol 1999), in anthropology (Holbraad and Pedersen 2018; Holbraad, Pedersen, and Viveiros de Castro 2014; Kohn 2013) and post-human philosophies including speculative realism (Meillassoux 2008), agential realism (Barad 2007) and object oriented ontology (Harman 2009; Morton 2016).

This is relevant for research and innovation as lyseology is mobilized to convince policy makers and the public that the 'problem' in the present should be addressed through the learned, effective, and efficient manipulation of such a container world. The ambition is to co-produce (Jasanoff 2004) some new artifact (or knowledge, to be more general) that fills the lack and thereby solves 'the problem'. What follows is that policy makers are convinced that the problem 'exists', the lack is 'solvable' and if research and innovation is done ethically and responsibly, a solution 'to the world' will present itself.

Traditional ontological discourses are normative: they tell us how 'the world' *should* be conceptualized (this is the logos/discourse *about* the ontos); what the world *is* (this is the ontos *itself,* a one-world world)*;* which kinds of entities exist within *the world* (this is the constitutive normativity of ontological discourse in philosophy) that is denoted with the singular definite article. A radically reflexive philosophy, on the other hand, is guided by Giorgio Agamben's suggestion to move 'from political philosophy to first philosophy (or, if one likes, *politics is returned to its ontological position*)' (Agamben 2017, 40 my emphasis).

In traditional political theory the constitution of human and non-human entities is stable. Politics reflect on the relationships between persons or things, humans or non-humans that are fixed and given. Political questions concern who holds power over what and whom, by what means, through which institutions and how these processes are made visible or are occluded. Moving the venue of discussion on the politics of RRI to practical political ontology has profound implications for how we assess the robustness of a philosophy of RRI in political terms.

Agamben's guidance enables my inquiry to move political ontology from being an exercise providing the fixed foundation for the exposition of the problems that are particular to the political to reflecting on the constitution of entities and their relations as an event. Put another way: the world and entities 'therein' are not assumed as given but possibly are in a state of (ontological) flux. This is one aspect of a possible politically robust philosophy of RRI: it is not *in* the world that things *are* (exist in a world that is 'out there' as pre-formed entities) or *are made into* and have impact *on* the world and each other. Bodies, artifacts and networks are *ontological events* that are continuous beings as enactment *of* the world.

Understood this way a robust philosophy of RRI discusses more than shedding light on *impacts* of fixed entities or how (fixed) non-humans are (ethically, socially or otherwise) entangled to (fixed) humans as hybrids, cyborgs or networks. It is not entirely obvious what distinguishes humans from non-humans in a radically reflexive philosophy, and non-humans could be empowered to be included in the material semiotic network of actants (Latour 2005). Moreover, as Mol (2021) shows in her critical work on humanist political anthropology, properties and boundaries of 'reality' and entities 'therein' may not be fixed *in* the world. Mundane performances, such as eating – transforming, digesting, excreting – happen or are enacted as much inside as outside of the body. We may understand the imaginary of R&I (and science in general) to be the political constitution of humans and non-humans as the very creation of boundaries, properties and entities *of* the world (Garfinkel 2022).

Stakeholders in RRI

As said, the modernist OWW philosophy has been at the heart of the move toward a hegemonic globalized capitalism, and by creating the binary of social/natural, such philosophy and its correlate economics has transformed 'nature' into 'resources' to be extracted by economies of human service. The call for inclusion (Stilgoe, Owen, and Macnaghten 2013) in public debates and deliberations of technosocial challenges (Braun and Griessler 2018) or that 'societal actors and innovators become mutually responsive to each other' (Von Schomberg 2013) uses the concept of 'stakeholders'

(Freeman 1984; Mitchell, Agle, and Wood 1997). This is taken from strategic business theory to conceptualize of lay or societal actors in R&I contexts. The *stakes* of stakeholders are defined based on what is deemed desirable from the OWW point of view and of human utility.

The discourse of stakeholder inclusion into the 'innovation process and [the creating of] its marketable product[s]' crafts an assemblage of people, technologies, and things whose world 'out there', together with the risks and claims (Clarkson 1995) that constitute their stakes, is defined in terms of the OWW and its economics of exploitation and violence (Böhm and Pascucci 2020). Risks and claims are defined in terms of impacts (on humans and the world 'out there'); agency and political capacities are attributed to humans only, thus sustaining the particular assumptions about the ideal attributes of democratic subjects as well as conventions of human independence and autonomy.

Engaging stakeholders in public deliberations about technosocial futures neglects the reality that actions and opinions of public citizens are inseparable from the publicly performed sociotechnical imaginaries that they are made to understand and share (Jasanoff and Kim 2009, 2015). Stakeholders are coerced into dwelling in the imaginaries powerful ontographers have endowed the spectacle called reality with (Braun and Randell 2022; Debord [1967] 2014). This is what Ehrnström-Fuentes and Böhm (2023) in a different context call 'ontological occupation' that shapes subjectivities in ways that radically different technosocial futures, the ontologically otherwise (Woolgar and Lezaun 2013), become unthinkable.

Radical reflexivity: a critique of social reality

The concept of radical reflectivity was introduced by Melvin Pollner, an early disciple of Harold Garfinkel, in the development and practice of ethnomethodology (Lynch 2012). Pollner (1991, 370) argues that radical reflexivity.

> enjoins the analyst to displace the discourse and practices that ground and constitute his/her endeavors in order to explore the very work of grounding and constituting. Intrinsic to radical reflexivity is an "unsettling," i.e. an insecurity regarding the basic assumptions, discourse and practices used in describing reality.

Reflecting on ethnomethods – the seen but unnoticed assumptions and practices of social action and the ways in which such actions are disattended – it is suggested, is a way to contribute to a better comprehension of the nature, significance, and function of norms, reason, and agency in social life (Garfinkel 1991). Ethnomethodological reflections foster an awareness of actors as more complex than the straightforward, rational agents that other viewpoints imply they are. Ethnomethodological inquiry encourages research on how people interact in various organizational environments, including the sciences, relying on habits, abilities, and assumptions that are taken for granted to accomplish intelligible and accountable (inter)action. What may be relevant to the subject at hand is that ethnomethodology shares with STS an epistemic critique towards social reality as well as a mode of inquiry to address 'facts', 'reality', and 'action' as social constructs, and a critical empirical orientation towards local orderliness (Lynch 1993).

Studies of ethnomethods of scientific practice and the ethnographies of STSers challenge the received versions of science and present an alternative picture of science that

arises from on-site observations of laboratory practices (Garfinkel 2022; Latour and Woolgar 2013; Merz and Cetina 1997; Stephens and Lewis 2017). Constructivist and phenomenologically inclined social science have claimed that a univocal accounting provided by an 'objective' science detached from any traces of experience, society, and history is a myth. However, it is rarely questioned (except in more radical versions of STS) that the technoscientific world made into the lifeworld of choice for everyone by post-scientific revolution modernity is also a methodical enactment (by science) as a context dependent account of how we shape and give meaning to our surroundings. This is important when thinking of research and innovation. R&I is based on a naïve assumption that the above concepts ('facts', 'reality', and 'scientific action') as well as other 'entities' that STS, mobility studies and ethnomethodology have already problematized – a chemical substance (Latour and Woolgar 2013), an animal dietary supplement (Lynch 2013), a disease (Mol, Smith, and Weintraub 2002), or even mundane artifacts such as a car (Urry 2004), a transport container (Birtchnell, Savitzky, and Urry 2015), a bridge (Joerges 1999) to name a few – are just what they seem to be for the naked eye: simple 'things'. Concepts, entities, and artifacts in R&I are seen as stand-alone, agencyless objects in a world that is 'out there' preexisting their relations, politics, and networks of meaning.

Ethnomethodology suggested a radical shift from engaging with the taken-for-granted skills, assumptions, and practices to accomplish intelligible or accountable interaction. The ambition was to reflect on the 'ontological space' in which such skills and assumptions, and reflection on them is even possible and intelligible. Radical reflexivity was part of the original program of ethnomethodology to displace inquiry from the foundations of traditional social science discourse and practice (Pollner 2012). As such, its onset was a forerunner of the 'ontology turn' in the social sciences *avant la lettre* (Lynch 2012).

Radically reflexive inquiry creates problematic assumptions about social reality, truth, and correspondence without making it apparent what, if any, alternative discourse might take its place. Put otherwise in our context: 'lack' and 'solution' are taken out from the equation of inquiry. 'One is not observing from a secure vantage point: The securing of secure vantage points is the phenomenon' (Pollner 1991, 374). Radical reflexivity shifts attention to what analysts – scientists, theorists, scholars – are doing in the first place: that any reflective activity is in itself shaped by and grounded in assumptions, practices and bodies of knowledge (Garfinkel 2022) that are sanitized and normalized (Latour 1999) for all practical purposes (Schutz 1967). It is modes, ways, and processes of 'securing' that become the object of the inquiry. Radical reflexive inquiry is antagonistic toward lyceology as it does not produce descriptions, accounts, or hypotheses: it questions the conditions and processes that constitute descriptions as an intelligible possibility. As Pollner (1991, 375) suggests:

> Because they strive to delineate the outer limits and constraints of a discourse or practice - to examine the boundaries from the other side - reflexive inquiries seem indefensible in terms of the discursive criteria imposed from within. Given their reluctance to develop a paradigm, system, or theory, radically reflexive inquiries do not articulate criteria, concepts, or methodology. Moreover, radically reflexive inquiries withhold commitment to prevailing practice and discourse and, although they do not (seek to) debunk a particular discourse or cluster of practices, the effort to move beyond the prevailing frame intimates that practitioners' accounts are incomplete or naive. Thus, radical inquiries seem groundless and subversive

> and raise daunting ontological and epistemological issues for those already within the ontological space of a discipline.

Radically reflexive inquiry marks a move from the epistemic to the ontological as it directs attention to reflection itself being formed and constrained by what Pollner calls the 'outer rim' of practice and process (Pollner 1991, 376). The reflective gaze that is concerned with 'reality', social or otherwise, diverts the practices that create the processes constituting the discursive and institutional venues within which particular practices are deployed. Thereby, radical reflexivity avoids constituting the 'place' within which the spectacle that is considered to be 'reality' and their observers appear (Debord [1967] 2014). In the case of R&I practice this may refer to the institutional venue of 'innovation', the discursive place of 'lyceology', and the 'responsible' practice that guarantees compatibility with expectations of a preexisting or imagined and shared future social reality that is 'out-there' (Jasanoff and Kim 2015).

According to Pollner, it was no surprise that in order to integrate and assimilate ethnomethodology into at least the 'suburbs' of traditional sociology such a shift from epistemic critique to ontological uncertainty was unwelcome. The emerging discourse of incorporating ethnomethodology into the high church of sociology as microsociology (Hilbert 1990), conversation analysis (Heritage and Stivers 2012) or the study of routine social interaction (López-Cotarelo 2021) distilled it in ways that elided its radical potential. Ethnomethodology as a form of the sociology of 'the local' and 'the performative', like most of the human sciences as practiced today, suppresses reflexivity and settles down with a phenomenon or a topic without commenting on the practices that permit, invite, and constitute 'settling down to the topic' (Garfinkel 1991). Partaking in reflection as a Cartesian exercise, these versions of ethnomethodology necessarily participate in the practices that provide the sense of a 'world out there' awaiting description and analysis, and are cautious with regard to which descriptions may be more or less comprehensive and true (Pollner 1991).

Experimental ontology, public engagement, and more democratic R&I

To kickstart a conversation about potential building blocks of co-creating a more robust philosophy of RRI, I now turn to alternative responsible practices. While a socio-material reordering of the world by technoscience is generally accepted, democracy is still conceived of in terms of a representationalist epistemic worldview (Mol 2021). An alternative approach could be to extend radical critique to deliberative or dialogic concepts of democracy or to categories of the public and democracy (Marres 2013). In this vein Marres (2015) proposes attributing political capacities to non-humans in order to disrupt particular assumptions about the ideal qualities of democratic subjects, as well as conventions of human self-determination and post-Cartesian ideals of autonomy, which posit that the actions and opinions of public citizens are not to be dictated by their particular, material circumstances.

It has been suggested that RRI should be grounded in the deliberative democracy of autonomous citizens as 'citizens have the capacity to search for and collectively formulate the common good within public deliberations that link common good, justification and legitimacy, and respect the autonomy of citizens' (Reber 2018, 58). However, the ideal of the autonomous citizen has been challenged in the social sciences from manifold

disciplinary positions (cf. Butler 1999; Foucault 2006; Vaneigem [1967] 1983) as has been a humanist politics that posits that democracy is exclusively about humans acting in concert (Mol 2021). Demonstrating that agency is more distributed among a variety of human and inanimate actants, and human *and* non-human agents act together (Law 1986, 2009; Mol 2021) an exclusively humanist politics as 'more responsible' became untenable. In order to overcome the reluctance to engage with non-humans on the level of public debate, an 'experimental ontology' should consider the deliberate investment of non-humans with moral and political capacities and direct attention to efforts to purposefully design politics and morality into material objects and settings (Marres 2013).

Moreover, this leads to examining, in a radical reflexive vein, how politics and democracy are accomplished through the deployment of devices, objects and settings, rather than accounting for politics and democracy in an epistemic register, that is, in terms of the deployment of discourses and ideas only (Marres 2015). Experimental ontology proposes that ontology work is distributed among entities and actors that each operate across conceptual and empirical registers. A distinctively material mode of public participation may be accomplished in a distributed way as material setting, social actors, technologies, and researchers all contribute to it. In this setting empirical and theoretical work is shared among differently positioned actors to the point that this distinction between the conceptual and the empirical becomes blurred and unstable. Material objects are made to play active and visible roles in the enactment of engagement and deliberation: absorption in material settings and activities is central to the very enactment of environmental engagement. These settings contribute to the normative project of the insertion of non-humans into democracy.

The unsettling attributes of radical reflexivity revived as experimental settings facilitate many kinds of approaches to material participation from the disciplinary to the affirmative and as such, they are normatively unstable. Experiments may be characterized as devices for producing indetermination for suspending and/or undoing established ontologies. Experimental political ontology proposes that the investment of non-humans with political capacities and their insertion into democracy are projects of experimental settings.

Suspending one-world world ontologies

The politics of current RRI is anchored in a Global North OWW frame (Wong 2016) that is patently different from an experimental, relational ontology and its associate politics. In order for RRI to remain relevant, the outer rims of a subject independent world, the great divide between nature and culture, and the binary of moderns and nonmoderns must be addressed (de Castro 1998; Latour 1993). RRI could challenge lyseology and assist R&I to be informed by relational more-than-human ontologies (Bastian 2017) and a pluriverse philosophy (Escobar 2020; Law 2015; Law and Lien 2018). 'Lack', 'problem', imperfect artifacts or technologies awaiting betterment would thus not be seen as pre-existing the relations that constitute worlds – as R&I (and RRI) currently conceive of these.

Sciences, studying objects categorized under headings of the 'natural' or the 'social', as well as more mundane forms of performative sense-making (looking, moving, eating,

loving and so forth) employ what may be referred to as rudimentary Newtonian ontology: a hypothesis that space and time are fixed structured background entities underlying material reality, which participate in governing the motion of physical objects. Such a Newtonian container world is not self-evident: the dominant view in the European tradition, from Aristotle to Descartes, was to understand space and motion as (only) relational. This means that the world is supposed to consist of physical objects (particles, bodies, fluids) that have the property that they can disturb, or not, one another. Space is the disturbance: the relation between objects. Newton suggested otherwise: he hypothesized that space is an entity that exists by itself, and objects may move in it (Rovelli 2006). The revelation about the Newtonian ontology was that it is extremely helpful in making pretty good predictions (e.g. implicit or explicit measurements) about the behavior of entities that populate the world. However, the currently most accepted theory of space, time and entities, as Carlo Rovelli (2006, 28) explains, argues that 'in Newtonian physics, if we take away the dynamical entities, what remains is space and time. In relativistic physics, if we take away the dynamical entities, *nothing remains*' (my emphasis).

From my ontological constructivist and pluriversal political perspective there is not *one* alternative ontology or a 'better' ontology that is more attuned to how the world *is*. My ambition is rather to show that the 'ontological otherwise' is possible by thinking of thinging (Heidegger 1971) differently than of Western OWW. Engaging with agential realism for instance, a materialist, quantum theory inspired philosophy that conceives of matter and discourse as inseparable continuous world-making practice would afford RRI with a conceptual apparatus to experiment with the ontological otherwise and challenge lyseology (Barad 2003, 2010; Juelskjaer and Schwennesen 2012; Warfield 2016; Webb 2020).

In agential realism, the smallest unit of the real is a phenomenon: the local entanglement of 'object' and 'agency of observation' (Barad 2007). Objects (from the smallest to the largest) do not have determinate properties (e.g. they do not exist as 'things' in 'time-space', nor does temporality or spatiality exist before such entanglement occurs); they become determinate when they are entangled with an apparatus (the agency of observation). The entanglement does not make the object and the agency of observation one entity, but when a device is in position, the specific material arrangement enacts a cut between the 'object' and the 'measuring device' such that the boundaries and properties in question become determinate (Bohr 1928; Carroll 2019; Lewis 2016; Rosenblum 2012). This cut is the violence of the political ontology of a world by which the notion (of any property that is measured) becomes meaningful, and the value of the corresponding property becomes definite.[3] In the absence of such violence, the concept of the measured property is meaningless, and there is no fact of the matter about the boundaries and properties of the object (Barad 2007, 263).

In an agential realist 'otherwise' things/entities are not in the world awaiting to be found, discovered, determined, created or manufactured; nor are they socially or linguistically constructed by processes of knowledge or language and found thereafter. The world (reality) is assumed to be the ongoing reprocessing and reconfiguration of locally determinate causal structures with local boundaries, properties, meanings, and patterns of marks on bodies. This does not take place in space and time but *is* the making of spacetime itself (Barad 2010).

Reality is conceived of not as something already fixed or demarcated, nor are entities therein. There is a constant 'dance of agency' (Pickering 2017) through which one part of

the world makes itself apprehensible to another part. This ongoing open process is how matter – things, entities, objects, and artifacts – are becoming (acquire meaning and form) by fixing different agential possibilities. Space and time are only meaningful *in* and *by* phenomena as in-between of specific agential connections. Phenomena are 'intra-connected' (as opposed to interconnections of already formed entities); swarming reconfigurations of the very small (e.g. micro-world) and big (macro words e.g. human scale) (Juelskjaer and Schwennesen 2012).

Boundaries, properties, meanings are unusual configurations: not necessarily the human body (Mol 2021); nor specific humanly perceived living objects, like a tree (Sheldrake 2021); nor a car or the road (Braun and Randell 2022); but swarming, dancing agencies coagulating and dissolving in observation and being observed. Mattering (becoming a 'thing') is a process: a more-than-human event through which boundaries are constituted, entanglements are fixed (Heidegger 2013; Whitehead [1929] 1979).

Barad (2003, 817) argues that '[t]he world is an ongoing open process of mattering through which "mattering" itself acquires meaning and form in the realization of different agential possibilities [… t]emporality and spatiality emerge in this processual historicity'. Research and innovation, as we know it, is such *human mattering*: creating, collating, manufacturing, extricating worlds. It is congealment in historical time; a strategic apparatus that creates the conditions of possibility of manifold forms of being (human, non-human, inanimate), whether of discourse or silently invested in material practice. It is the form of spatiality, temporality, thinging and worlding that define conditions of political being for all 'things'.

The otherwise of responsible research and innovation

Agential realism is, of course, not the only attempt to imagine alternatives to modernist assumptions about worlding, thinging, and human–non-human entanglement. New materialist approaches critique an ontology of modernism, of both a profound belief in technoscientific progress, and faith in its promises of an existentially better lifeworld (Bennett 2010; Harman 2009; Morton 2012). What connects these imaginaries, beyond their political ambitions, is that mattering is seen as a complex process of (more-than-human) knowing, doing and relating (Barad 2007; Mol 2021). Ontopolitically informed responsible research and innovation should be reflexive of, experiment with, and work towards modes of more-than-human knowing, doing and relating-with.

In other words: instead of binaries of more/less, sustainable/non-sustainable, cost/benefit, ethical/unethical, trustworthy/fake and so forth – all of which have the container world and the independent, autonomous and sovereign human at their center – radical reflexivity and experimentation could move RRI to being aware of and responsive to conditioning flows of sociomaterial machinations which create worlds, entities/events and their politics. This is what Foucault (2001) refers to as 'problematization' or what Latour (2004) talks about when he urges us to shift from 'matters of fact' to 'matters of concern'.

To be somewhat more radical and to connect these strands of thought what I am suggesting is that RRI should engage with the concern that the 'ontological order of things is itself the outcome of a political struggle: Ontology is politics that has forgotten itself' (Oksala 2010, 464). Lyseology is the politics of transformative forgetting: reality

and entities acquiring the form of unproblematized and objective givens, 'facts' as opposed to 'things-in-becoming' that are gathered as concern. Lack is inscribed into reality by lyseology and R&I is mobilized to fill this lack; time is constituted as an arrow that points the container world from a present state that includes the lack to a future state that is void of lack and thus (somewhat) bettered.

Stakes do not belong to humans or impact the 'out there', but stakes constitute the world. In worlds without pre-existing objects or things everything is always made up of materials in motion, flux and becoming (Barad 2007). In these worlds beings of all kinds constitute each other's conditions for existence. Humans, lay or otherwise, do not talk *about* (e.g. reflect *on*) and mitigate risks and claims as stakes constitute them in their relations with other humans and non-humans. Risks and claims open towards response-ability (Barad 2014; Blok 2020; Haraway 2008): to the possibilities of co-constitution and mutual response, which is not to occlude, but to attend to power imbalances. Agency is not something possessed by or belonging to humans, or other beings – it's an enactment. This speaks to the particularities of the power imbalances of the complexity of a field of forces (Barad 2012). What can be experimented with is doing/performing normative more-than-human instability: unsettling realities (Pollner 1991), upending ontologies (Escobar 2019), producing indetermination (Marres 2013) and deactivating the modern apparatus (Agamben 2014) – sharing stakes to create temporally and spatially limited more-than-human relations.

RRI should utilize radical reflexivity as mode of inquiry to move away from a One-World World (OWW) ontology. This would allow for thinking of R&I as machinations of socio-technical-material arrangements that create worlds *into* a pluriverse and not artifacts into *the* world that is single and independent from such machinations. It is not a world that things are made into. Entanglements and networks are ontological events that are continuous 'spacetimematterings' (to use Barad's expression (Barad 2007)) *of* the world. R&I is as much the political constitution of humans and non-humans *in* the world as it is the very creation of boundaries, properties and entities *of* the world. Things (phenomena, matter) do not move in time or evolve through time but *do* time. Spacetimemattering.

> call into question the classical Newtonian conceptions of time, as an unabated continuous flow moving inexorably from past to future, where the past is passed and the future will unfold on the basis of what is the case in the present moment, but also the assumed existence of a present-past and the very possibility of erasure without trace. [… W]hile the past is never finished and the future is not what will unfold, the world holds the memories of its iterative reconfigurings. All reconfigurings, including atomic blasts, violent ruptures, and tears in the fabric of being – of spacetimemattering – are sedimented into the world in its iterative becoming and must be taken into account in an objective (that is, responsible and accountable) analysis. (Barad 2018, 73)

For RRI to remain sites of debate, of praxis and of politics I suggest an ontopolitically experimental more-than-human approach to its politics. Such politics is based on a pluriverse philosophy and a rhizome logic of human–non-human entanglements. Humans and non-humans (animate and non-animate alike) share the experimental space (Bastian 2017) and become attuned to the co-created and shared worlds they enact together (Murris 2021). As beings of all kinds constitute each other's conditions of being, risks and claims open a reflexive space of response-ability: doing/performing more-than-human instability that upend ontologies and produce indetermination.

Cartesian doubt, Galilean geometry, and Newtonian physics had mattered (created entities of various kinds with) determinate properties of subjects and objects. This offered the comforting belief in naive realism (Oksala 2010). Conviction in ontological stability and quest for determination to fill lacks *inscribes* lack into the world humans dwell (Lynch 2019). Spacetimemattering, conceiving of knowing, doing and relating matter otherwise, is void of lack as there is no space *inter* subjects and objects, or the binary of social and natural, or a 'world' and entities 'therein'. Reimagining RRI in terms of spacetimemattering would suggest a continuous intra-acting ontological experiment (Barad 2017).

Conclusion

This paper investigated how new pathways to transformative RRI politics could even be imagined. I have suggested that for RRI to live up to its potential a more radical shift from the one-world world is required. R&I in OWW is characterized by 'lyseology': the mobilization of science and its applications to convince policy makers and other publics that the present possesses some form of lack that a new technology brought to the world will fill. It is remembering the world as having the form of an independent apolitical given. By forgetting the politics of mattering lack becomes the space *in* the world that must be filled with ever newer and better artifacts. This is the politics of transformative forgetting.

The shift may utilize radically reflexive forms of inquiry by taking lack and solution out from the equation of inquiry by moving attention to the assumptions, practices and bodies of knowledge that stabilize worlds. While radical reflexive inquiry may seem as pointless from an OWW view as it does not produce descriptions, accounts, or hypotheses, it questions the conditions and processes that constitute descriptions as an intelligible possibility.

Following up on radical reflexivity an experimental R&I ontology suggests that material objects should play active and visible roles in the enactment of engagement, deliberation and in more democratic research and innovation. The absorption in material settings and activities is central to the very enactment of environmental engagement. These settings contribute to the normative project of inserting non-humans into democracy.

As emphasized, from a pluriversal political perspective there is no 'real', 'better' or 'true' ontology that is more attuned to how the world *is*. Agential realism is one avenue to imagine the ontological otherwise and to think with thinging differently than that of Western OWW.

As David Deutsch (2010, 551–552) wrote in a different context, if some of our basic intuitions about reality and world(s) may be plain wrong, we need to learn to think in terms of this breakdown, build on understanding it, and apply it to learning about everything else, discover its successor. In physics, to which this reference was made, as in Responsible Research and Innovation, with which we are concerned.

Deep core, basic ontological and normative beliefs are resistant to change. Policy makers, engineers, innovators, researchers – ontologists and ontographers – could experiment with, engage in, and radically reflect on thinging otherwise. We live in the world of modernity, one world of many worlds that has been co-created by its ontologists and ontographers. It is a world that increasingly makes its presence felt, to humans and

non-humans alike, through the violence of human mattering that is called (technoscientific) progress. The political ontology that we are made to inhabit is the ontology of Cartesian dualism and Newtonian causality. Thinging (creating, fabricating, extracting, imagining, mattering things) otherwise requires a turn to and shift in ontology, quantum or otherwise.

Notes

1. From the Greek word lysi (solution) and logos (knowledge). Lyseology is the use and misuse of science to produce 'lack' as a problem and offer knowledge of a better future in which the lack as problem is solved. It is an alternative version of agnotology (Proctor and Schiebinger 2008): the use and misuse of science to produce ignorance in support of corporate interests.
2. ontos/world in plural and genitive.
3. This is akin to what Heidegger refers to as 'thinging' as gathering the fourfold and the violence done to the 'thingliness of the thing' by thinking (Heidegger 2002, 7).

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