Responsible Innovation in the Light of Moral Responsibility

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1. Introduction

The development of technology and research in the twentieth century is rife with controversies. Examples include: global warming, nuclear power (fusion and fission), genetically modified organisms (GMOs), current research on shale gas (fracking), synthetic biology, geo-engineering proposals, developments in Information and Communication Technologies, not to mention the scandal of bovine spongiform encephalopathy (BSE). These new issues have triggered strong public reactions, and have increased the need to find new methods to monitor, control, organize and shape innovation in science and technology. In recent years, these new methods have evolved into the political formulation of responsible research and innovation (RRI) in Europe (EC, 2013).

The idea of science and technology meeting societal values is not new. RRI furthers different traditions, which originated in bioethics, in ethical committees focused on various technologies (biomedicine, ICT), and in technology assessment (TA) and participatory technological assessment (PTA) practices. Furthermore, RRI continues the ethical reflection on technology and research, as framed by ethical legal and social impacts and assessment (ELSI and ELSA) initiatives which emerged in the early 2000s at the height of the controversy over the development of genomics. In addition, reflections on corporate social responsibility (CSR) and sustainable development have also paved the way for the inclusion of ethics in the shaping of technology. From a reconstructive point of view, one could argue that RRI brings together the democratic stance of PTA and the idea of responsibility contained in CSR. It furthers these different traditions (which have been evolving in parallel worlds) and embraces the inter-disciplinarity initiated by PTA and ethical committees (which respectively involved experts from computer sciences, ICT, the political sciences, sociology and management sciences and from bioethics, philosophy, theology, law and medicine).

Compared to PTA, designed as a pluralist attempt to build normative assessment, or to ELSI whose approaches are based on expert driven ethical evaluation, RRI theories link social and ethical desirability to the 'responsibility' of those involved in innovation and research processes (scientists, innovators, policy makers, interest groups, end-users, etc.). Authors such as Guston (2004), Grunwald (2011), Stilgoe *et al.* (2013), Owen *et al.* (2012, 2013b) and Von Schomberg (2013), or a report from the European Commission published in 2013 (EC, 2013b), have gathered

recommendations already promoted in TA approaches together and proposed several conditions for RRI to be operative: anticipation, transparency, reflexivity, public participation and responsiveness, which is only one possible meaning of responsibility. Although this approach shifts the focus from an explicit ethical enquiry towards the idea of responsibility, the concept has remained surprisingly under-investigated in RRI literature from a theoretical point of view. Von Schomberg (2013) for instance offers some insight when he analyses cases of 'irresponsibility'. Yet, the very definition of 'responsibility' (of who, to whom, where, when, in what way) has never been considered systematically, although this vagueness hinders RRI's practical relevance.

In order to fill this gap, we will investigate some of the many dimensions of the concept. However, we will not advocate a single normative understanding of responsibility. On the contrary, we will defend a pluralistic conceptual view thus avoiding, on the one hand, a monistic approach (where a single moral element – or hierarchy of normative elements – is relevant) and, on the other hand, a relativistic perspective (dependent on non-moral reasons, that are factors or causes only), which would eclipse the normative discussion (Reber and Sève, 2006).

Section 1 briefly presents a short genesis of RRI, identifying two main perspectives: the 'pillars' supported by the European Commission on the one hand and a more procedural approach focused on the 'conditions' for RRI to be operative on the other. We underline some of the issues raised by the current under-determination of both frameworks, which stems from their theoretical weakness in defining responsibility.

It should be mentioned here that most RRI approaches do not distinguish between research and innovation. Both sets of practices are considered on the same level, an approach which neglects their respective specificities and constraints, such as differences in the hierarchy of their aims, their respective temporalities and their different sensitivities regarding the assessment of potential damage. Focusing on supply chains and networks, we will confine ourselves to studying the link between innovation and responsibility (responsible innovation; RI). This approach does not deny that research is also an important part of RRI.

Hence, to deepen our understanding of the concept of responsibility, Section 2 considers the case of CSR in which responsibility is conceived of in the specific context of business practices. The particular constraints of innovation (such as the need for secrecy or the complexity of supply chains in multinational organizations) contradict the fundamental conditions laid out by certain RRI analysts, and particularly transparency and responsiveness. More generally, with the exception of Blok and Lemmens (2015), Pavie *et al.* (2014) and the special issue of this journal, the business context has been largely neglected in RRI literature. In revisiting the idea of responsibility implemented in CSR, we will highlight elements that might inspire a more practical view of RI in supply chains.

We nonetheless argue that CSR does not fully exhaust the question of responsibility in innovation. Taking a closer look at moral philosophy, Section 3 offers a general conceptual mapping of the different meanings of responsibility to add to the literature on both CSR and RI. We distinguish between negative and positive understandings of responsibility, i.e. between a passive approach to responsibility, focusing on damage and sanctions, and an active understanding that seeks to prevent harm and identify more positive outcomes. The promoting of a positive and proactive approach is designed to alleviate alleged tensions between innovation and responsibility (which are sometimes depicted as forming an oxymoron).

Finally, Section 4 illustrates how the different meanings of responsibility can be combined in RI. One main issue relates to the question of how responsibility is distributed along a complex supply chain and attributed to specific actors. Useful work has been carried out by moral and political philosophers and law theorists, when, for instance, they focus on the tension between causal determinism and freedom, or on the definition of control, secure competence and negligence (i.e. Raz, 2011). However, this work, which focuses on personal moral responsibility, has not yet been translated into an RI framework. We therefore scrutinize the practical relevance of meanings of responsibility in the context of innovation in supply chains and innovation networks, to offer a moral understanding of chained or networked responsibilities. To improve RI implementation, we discuss in what contexts some of the meanings of responsibility best apply and how they help to conceptualize responsibility in supply chains and networks.

2. Different conceptions of responsible innovation

Adopting a schematic perspective, two main approaches to RRI that combine various factors or pillars can be distinguished.

The first approach aims to improve the societal alignment of research and innovation by enhancing different factors

selected and promoted by the European Commission: (1) citizen engagement and participation of societal actors in research and innovation; (2) science literacy and scientific education; (3) gender equality in research and innovation and the gender dimension in research and innovation content; (4) open access to scientific knowledge, research results and data; (5) research and innovation governance (including ethics) (EC, 2013a). These five factors or dimensions of the 'Science in Society' programme are designed to better align research and innovation outcomes with the values, needs and expectations of European society and to ensure that the aims of European research and innovation potential are realised.

The first of the many issues raised by this approach, is that the EC has presented the five pillars without relating them to the goal they are expected to achieve: the pillars themselves are helpful, but there is no mention of how they will reveal the values and needs of society and how they will ensure 'a better alignment' of interests. Secondly, European citizens are divided about certain types of innovation. The five pillars could undoubtedly contribute to starting and organizing debate, as PTA procedures do, but further work on their coherency is needed to deal with the conflicts resulting from the heterogeneity of European societies. Thirdly, and most importantly for our argument, the brackets surrounding the word 'ethics' in the phrasing of the fifth pillar are worth pointing out: they seem to suggest that ethics is included in or restricted to governance, i.e. that the normative dimension of research and innovation (R&I) are not investigated *per se*, but diluted in the social and political processes through which science and technology are dealt with and monitored. Such a conception of RRI would be very limited: it would neglect a prominent dimension of ethics, i.e. our links with the external world (including inter-human relationships, but also the environment and non-human beings, etc.). In addition, ethics deals with many other issues beyond governance or cooperation, as illustrated by the debates in meta-ethics on values motivation, the field of individual ethics or the debate surrounding the notion of responsibility in moral philosophy – which never broach the issue of governance (i.e. McKenna, 2012; Raz, 2011).

Based on a more procedural framework, the second approach to RRI focuses on the conditions that R&I processes should satisfy in order to be considered as responsible (Armstrong *et al.*, 2012; Barben *et al.*, 2008; Grunwald, 2011; Guston, 2006; Hellstrom, 2003; Lee, 2012; Owen *et al.*, 2009, 2012, 2013b; Von Schomberg, 2011a,b). Not all authors focus on the same conditions and the number of conditions and content differ. However, five dimensions are more frequently investigated: anticipation (using traditional rational tools but also narratives and scenarios as a way to deal with uncertainty), responsiveness (conceived of as constant adaptation to a changing environment), reflexivity (thought of as the ability to challenge the framing through which assessments and decisions are made, inclusion (which calls for participation and sometimes deliberation as a possible means to align science and technology with societal values) and transparency (i.e. the need to circulate knowledge).

This approach seeks to improve the skills of individual, social, institutional and organisational players involved in R&I as well as the systemic qualities of research and innovation processes, so that their developments gain legitimacy by becoming embedded in the public's normative beliefs (i.e. values and value systems). Compared to the EC pillars that indicate general requisites, this perspective is based on the more abstract qualities of R&I. Thus, the issue of compatibility between both sets of factors remains unresolved. Furthermore, this approach raises other questions related to the implementation of R&I norms, the quality of deliberation and participation, the definition and realisation of reflexivity and the particular conceptions of responsibility used (Pellé and Reber, 2016; Pellé *et al.*, 2013). Finally, the procedural overtone of the second approach does not offer much more than the EC pillars regarding the ways in which ethical issues are identified and resolved. The assumption is that the ethical dimensions of R&I emerge from reflexivity, responsiveness, inclusion, etc. However, the practical correspondence between these conditions and ethical outcomes and justifications frequently remains unclear: the effective ways through which reflexivity and inclusion lead to ethically desirable outputs remain debatable.

We argue that the problems encountered by both approaches to RRI in explicitly addressing their normative dimension, are due to a lack of investigation into the very concept of responsibility. This is surprising as such, since responsibility lies at the core of what RRI claims to do. The reasons why theorists have defined RRI without framing the idea of responsibility then need to be explained. The lack of investigation is even more unexpected when focusing on innovation, since the decades-old CSR framework provides a normative approach to consider responsibility within business practices. However, CSR has rarely been related to RRI: although Pavie *et al.*, 2014 recently made progress in this respect, Owen *et al.* (2013a), for instance, only mentions CSR twice, and in unusual circumstances, in an article on RRI in finance. Furthermore, RRI literature rarely considers the specificities of the business context relevant to innovation. The only research that attempts to address these specific issues is the recent work of Blok and Lemmens (2015) and

Pavie *et al.* (2014). The following section considers how CSR literature can help to sketch a more accurate conception of responsibility in innovation and supply chains, and also what RI can add to these conceptions.

3. Social corporate responsibility and responsible innovation

The roots of CSR first emerged before World War II. However, it was only in 1953 that Howard R. Bowen came to significantly shape future reflections on the subject in his seminal book, 'Social responsibilities of the businessman' published in that year, (Carroll, 2009; Carroll and Shabana, 2010; Melé, 2009; Spector, 2008). Three core ideas about CSR stood out at that time: the idea of the manager as public trustee, the balancing of competing claims for corporate resources within the company, and corporate philanthropy – business supporting worthy causes (Frederick, 2009). The literature then expanded substantially from the 1960s until the end of the 1980s. It tended to focus on the question of what social responsibility actually meant and its importance to business and society. Different dimensions were investigated including corporate social performance and how it was assessed (how to measure and asses a private company's activities), stakeholder theory (focused on the relationships between private companies and all relevant stakeholders such as local communities, NGOs, policy makers and 'civil society'), and corporate citizenship (the firm being considered as a citizen with moral and legal duties and rights).

These perspectives differ in their focus and their characterisation of CSR. However, what they all have in common is the idea of responsibility as a way to extend the horizon of private corporations beyond their traditional profit maximization behaviour and encouraging them to consider the social impact of their activities. Carroll and Schwartz (2003), for instance, describe three connecting types of responsibility inherent to any company: (1) to make a profit; (2) to comply with national and/or international legal norms (e.g. Human rights, laws relating to child labour); (3a) to comply with existing ethical norms (e.g. ISO 26000, the Global Reporting Initiative), together with other norms recognised as socially valuable; and (3b) to engage in philanthropy. Noticeably, the ethical and legal part (complying with social and legal norms) goes hand in hand with the imperatives of economic efficiency. The social responsibility of firms implies the inclusion of variables other than profit in decision-making, even if the latter remains the primary driver.

CSR thus endeavours to envision the firm as entangled in a network of relationships (rather than being a purely autonomous agent). It extends the range of interrelations and impacts to be taken into consideration by corporates in their decision-making process, so that social, environmental and ethical impacts and consequences might be included. This attempt echoes the RI endeavour to open innovation and its consequences to different members of society (and to their potentially conflicting interests) rather than focusing only on economic or scientific actors. Both approaches align the processes of production, innovation and research with societal needs, interests and values. Furthermore, both approaches rely on the individual virtue of top managers, employees, innovators, etc. as well as on the systemic capacity of production and innovation processes to allow their outputs to be shaped according to ethical and social desirability, once specific normative constraints have been taken into account.

Thus, the CSR framework already provides a basis to develop the conception of responsibility in innovation. Pavie *et al.* (2014) for instance, scrutinize a number of issues and examples that show how CSR can be applied practically. It can shape innovation by challenging the private company's ceaseless quest for new goods, through a careful monitoring of a product's life cycle, or by anticipating and monitoring the medium and long terms consequences of a given product on health, lifestyle, or on the environment. CSR has also crystallized into a practical set of norms (ISO 260000), which effectively guide corporate governance. Finally, CSR sheds light on the complex issue of how responsibility is shared among supply chain actors. One example of this is when companies manage to impose CSR constraints on their partners' practices (e.g. Andersen and Skjoett-Larsen, 2009; Carter and Jennings, 2002). Another example is when corporate responsibility is restricted to a 'circle of influence' (i.e. the actions of main suppliers and stakeholders that a corporate entity can seek to influence, without having total control over) in order to allow the company to maintain its autonomy (Amaeshi *et al.*, 2008). In conceiving of the firm and its various stakeholders as an ecosystem, the CSR approach may well be useful for the implementation of RI's main features (i.e. responsiveness, anticipation, inclusion or reflexivity).

However, two issues that have only been partially tackled by CSR need to be addressed in the context of RI. The first of these is that CSR is sometimes based on too optimistic a vision of knowledge and rationality, where the outcomes of acts and decisions are seen to be identifiable and predictable. However, the intrinsic uncertainty of technological development, in which innovation plays a major role,

means that CSR fails to fully deal with unpredictable and/or unknown outcomes. Responsibility does not only rely on anticipatory capacities or the efficiency of knowledge production. An adequate conception of responsibility also morally engages individuals and organizations by virtue of their actions, whatever the consequences might be. This is true even if consequentialism is not fully renounced, i.e. if the actual consequences (and not only those that can be foreseen) of corporate activities are considered. For instance, compared to CSR, views of responsibility as care or responsiveness (Grinbaum and Groves, 2013), connect a moral commitment with our capacities of anticipation in contexts of attendant uncertainty.

Another limitation of CSR is the fact that in practice, firms tend to implement a restrictive conception of responsibility that is limited to compliance with existing norms. Studies on how CSR is carried out in the field of nanotechnology, (Groves *et al.*, 2011; Kuzma and Kuzhabekova, 2011a,b) emphasise that firms tend to conform to agreed standards but fail to adapt to new situations created by innovation. They tend not to adopt a proactive approach, on occasions when they should anticipate future developments and elaborate norms related to them. This is not to say that innovative business is not normally adaptive (c.f. Chesbrough's open innovation paradigm, for instance), or that CSR in itself hinders proactive approaches. However, what RI specifically addresses is a concern for moral innovation, in which adaptation to a changing environment implies reconsidering ethical, social and environmental assessments beyond mere compliance with existing norms, something that has not gained enough attention yet.

In other words, CSR has initiated a conception of responsibility among economic actors, which goes beyond their own economic benefit. However, it partly fails to take up the challenges of actual innovation and research, especially with regard to the way in which uncertainty is managed and ethical and social issues identified and possibly answered. In order to go beyond an implementation of RI that would be 'naive' according to Blok and Lemmens (2015), the epistemic question of the production of norms needs to be tackled (Pellé and Reber, 2016; Pellé *et al.*, 2013). Moreover, according to the European Commission, CSR could well become an additional RRI pillar (together with other factors already mentioned in EC calls for research projects, such as digital science, open science and open science education; scientific foresight and future TA, and social innovation), expressing the idea that RRI and RI have a wider scope than the concept of CSR.

4. Responsibility in responsible innovation: moral philosophy perspectives

Both the CSR framework and current RI literature are limited by their inexplicit conception of responsibility. And yet, moral philosophy provides at least ten or eleven different meanings of the concept, offering a variety of pathways for practical implementation. As synthetically, but only partially, presented by Van de Poel (2011), responsibility can be understood as a: (1) role; (2) task; (3) capacity; (4) authority; (5) virtue (care); (6) responsiveness; (7) obligation; (8) accountability; (9) blameworthiness; and (10) liability (our emphasis). Some authors add 11) causes or outcomes (Hart, 1968; Vincent, 2011), making both meanings equal (Perry, 2000). However, responsibility as a cause raises difficulties in moral philosophy as the freedom of either an individual or a collective entity is shelved when a deterministic conception of action is adopted (Fischer, 1999).

These various meanings can be divided into two different groups: the first one includes a 'negative' understanding of responsibility (in which actions are based on the threat of sanction), while the second set of meanings invokes a more prospective and positive understanding of responsibility, where future oriented players are concerned with certain courses of events happening (or not happening). Not all meanings are equally relevant for RI.

Negative meanings of responsibility

The first common interpretation of responsibility involves the attribution to a given individual or entity of acts carried out by them, which have had a negative outcome or have caused damage, which must now be compensated for or repaired. This imputative conception allows a distinction to be made between blameworthiness (when A can be blamed for outcome X, for instance, a car accident) and liability (A is liable to pay for the damages caused by outcome X). Negative understandings of responsibility also include a passive form of accountability (Bovens, 1998). These various approaches are backward looking, in that the responsibility is retrospectively assessed. The type of responsibility is external to individuals, because it relies on norms coming from the outside, which only influence the individual's acts through the threat of sanctions. This leads to a 'negative' conception of responsibility which is insufficient when considering innovation (and research) because: (1) it fails to include a normative involvement; (2) it may dilute responsibility; (3) it is understood to be without agent; and (4) it is restricted to the notion of external accountability.

Lack of normative involvement. Reducing the meaning of responsibility to liability alone creates a dilemma, which stems from the fact that the conditions for establishing one's responsibility rely too strongly on the burden of proof (Pellizzoni, 2004). To impute future damage on the basis of the knowledge available plays a part in building a purely instrumental view of responsibility. Not only is regulation rarely able to catch up with the development of technology (Lee and Jose, 2008; Owen *et al.*, 2013b), but complying with the law is only part of the comprehensive normative involvement of individuals since their behaviour will only be affected by fear of financial or legal penalties. For instance, complying with national safety legislation on nanotechnology or with the European Charter of Human Rights as claimed by Von Schomberg (2013) provides a first set of constraints on industrial innovation. It functions as a minimal requirement before setting a morally responsible production process in motion. However, ethical responsibility extends beyond a purely legal interpretation of responsibility since the law can be unethical (e.g. historical examples of legal slavery), and ethical behaviour can be illegal (e.g. Antigone's uncompromising refusal of the king's law, or the recent case of the whistle blower Edward Snowden, who publicly reported classified information, which violated US national security law). Moreover, the moral sphere of responsibility begins before and goes beyond legal frontiers; ethical concerns frequently arise before new laws have been discussed or enacted, as in the case of contentious interpretations of biotechnology. Interestingly, while the kind of responsibility involved in RI, PTA, CSR or sustainable development is not compulsory, many essays and definitions of responsibility are confusing on this point. We claim that RI also involves a form of moral innovation that adapts to changes in the environment. For example, safety rules will not always prevent possible harmful outcomes and RI also needs to go beyond available knowledge to develop and anticipate ethical norms and normative assessments of innovation, which might differ from current regulations.

Diluted responsibility. The second type of problem derives from the individualistic overtone of negative conceptions of responsibility based on a strong link between individuals and outcomes. When it is difficult to unravel the tangles of the causal chains that have led to a particular set of unacceptable outcomes, and when responsibility can be ascribed to too many individuals, there is a risk that in fine, no one can be held responsible at all. The philosopher Paul Ricoeur (1995) goes a step further when he mentions 'adjacent effects' that include the unexpected consequences of our acts. This raises the question of the extent to which individuals can be held responsible. A purely consequentialist approach to responsibility as promoted in liability, blameworthiness and passive approaches to accountability, collides with its own framework: in seeing responsibility as the result of a discernible causal process, one is confronted with the need to define the limits of reasonable time, space, and interaction to assess guilt. Yet, innovation and the attendant uncertainty surrounding it often challenge this rationalistic approach and require the way in which these limits are determined to be clarified. For instance, would it be possible to make someone or some entity (e.g. Monsanto's CEO) financially responsible, should a GMO or other form of biotechnology cause damage to the health of human beings?

The loss of agency. The third issue is linked to the historical evolution of our understanding of responsibility, which tends to remove it from individual agency. As argued by Ricoeur (op.cit.), the idea of solidarity against risk that led to the advent of insurance systems in the 19th century and to the welfare state in the 20th century altered the understanding of responsibility as implying obligation and repair in the case of fault. The institutionalisation of the management and prevention of social risks replaced the idea of individuals paying for damage they caused by a conception of responsibility in which potential risks should be prevented. This passive approach to responsibility illustrates the disappearance of the author of the injury. Such a change involves thinking about responsibility in a more prospective way (preventing risks is also forward looking), but it raises the same kind of difficulty as the purely legal interpretation. To what extent can public institutions prevent risk? Taking future generations into account (as in sustainable development, for instance), what is the time frame of the risk analysis? And using this prevention framework, who holds responsibility for complex and unexpected effects?

Responsibility restricted to the notion of external accountability. According to Bovens (2010), there exists a negative understanding of accountability, linked to the provision of a justification for one's actions, as when we have a moral obligation to account for what we did or for what happened (Blagescu *et al.*, 2005; Bovens, 2010; Van de Poel, 2011). This corresponds to a passive way of conceiving accountability as a mechanism that focuses on the relationship between a forum and an agent, i.e. on the obligation of the agent 'to explain and to justify his or her conduct' and the role of the forum in 'posing questions and passing judgment' (Bovens, 2010). Such a conception of accountability places the emphasis on political and social control and leads to an investigation of how accountability mechanisms function and what their effects are. This passive understanding of

accountability/responsibility, which is very common in corporates for instance, fails to deal with research and innovation, as it is not conducive to the anticipation of future change.

Negative interpretations of responsibility – liability, imputation, blameworthiness and the passive form of accountability – are effective and necessary. However, they never succeed in establishing a closer connection between individual decisions and acts and ethics. They do not offer a comprehensive approach to the practices, activities and capacities that a more positive form of responsibility leads to. Looking through the prism of these positive forms, it becomes clear that we are driven not only by the fear of sanctions but also by our wish to ensure that a certain course of events will or will not happen.

Positive meanings of responsibility

More prospective understandings of responsibility assume that individuals not only make up for the possible wrong they have done but engage in a process through which they take care of others (other human beings, future generations, non-human beings or the environment) by their actions. From this perspective, what counts is no longer being held responsible for a past action, but assuming forward looking responsibility. Various aspects can be distinguished.

First, a certain kind of responsibility is involved when an individual is given a specific task to accomplish or a specific role to take on (Hart, 1968; Van de Poel, 2011). Individuals are assigned to these activities and must ensure that they operate according to the best possible standards. In a similar vein, another aspect of responsibility relates to authority. In their professional activities, individuals are responsible for ensuring that pre-defined tasks are performed, and expected outcomes reached or avoided as the case may be. Their responsibility covers a broadened set of activities, compared to that included in the definition of a task, as it also involves the actions and decisions of other individuals. A fourth level of this broad set of 'positive' meanings of responsibility relates to the capacity to be responsible. Individuals must not only be able to act in a desirable way in order to be held responsible for their actions (a necessary condition), they must also show a capacity to act in a correct and appropriate way. Finally, a fifth level implies the notion of moral obligation when a social actor acknowledges his or her moral duty to act in a certain way.

These positive conceptions of responsibility entail the notion of moral agency. Assuming moral agency implies that we have the ability to reflect on the consequences of our actions and that we can engage in foresight through which we increase our knowledge of the world and how our actions might interact with and alter it (Grinbaum and Groves, 2013). This positive capacity also implies the ability to form intentions, to act deliberately, and to act in accordance with certain norms and moral or legal rules (Hart, 1968; Van de Poel, 2011; Grinbaum and Groves, 2013).

A further step in defining responsible innovation leads to the idea of virtue. Social actors can take care of and show concern for others and for certain courses of action. To overcome the deficiency of consequentialist frameworks, relationships based on care have been defended (Groves, 2009) and sometimes represented by means of a metaphor borrowed from the family: innovators (including entrepreneurs, scientists or a network of actors) should act towards their innovation as parents take care of their children (Grinbaum and Groves, 2013; Jonas, 1979). Obviously, the analogy will encounter some limits as the autonomy of technological artefacts, once they escape their creator's control, cannot be compared to that of a child becoming an adult. But, similarly to value-sensitive design approaches (Kelty, 2009; Van den Hoven, 2013), defining responsibility as care contains an interesting feature: innovators should shape the design of technology and follow up its development in a 'good' way, without being tied to the obligation of forecasting all possible consequences.

Another way of linking backward and forward looking conceptions of responsibility focuses on the dynamic of responsibility, i.e. on the ability to adapt and change one's own actions. Responsibility is then understood as accountability and responsiveness.

Accountability. We argued previously that a purely retrospective meaning of accountability did not exhaust the idea of responsibility. However, the idea of accountability also entails the active involvement of individuals as it associates the justifiability of decisions with the possibility of modifying one's actions (Grunwald, 2011). In Bovens' words, this second view refers to accountability as a 'virtue'. Thus, accountability can be understood as the active performance of agents who take other stakeholders' needs into consideration by engaging them in a learning dialogue. This approach stresses the 'process of learning' (as opposed to the 'mechanism of control') by which individuals learn to be responsive to each other and to adapt their behaviour in order to achieve 'substantive standards of good governance.' (Bovens, 2010). The role of accountability studies is then to formulate these substantive standards of good public or corporate governance and to assess whether officials or organisations comply with them (*op. cit.*). Here, the

possibility of modifying our actions, which is logically impossible in negative definitions of responsibility, plays a major role: it places responsiveness at the forefront.

Responsiveness. Among the various approaches to responsiveness, Blok (2014) proposed an interesting conception from the phenomenological tradition (as opposed to dominant analytic philosophy). This sophisticated approach integrates dialogue and difference, understood in Levinas and Deetz' terms and aims at making responsiveness fully responsive to the otherness of others. For instance, the goal of a stakeholders' dialogue in RI processes is no longer the self-expression of those involved in order to convince others, but rather to ensure that participants become critical towards their own interests and value frames. Therefore the ideas, positions and values of the subject are not only prefixed as input in the dialogue. 'In my dialogical responsiveness to the other, my identity as responsive to the demands of the other is constituted. Because my responsiveness is always limited and biased by our self-referentiality, our dialogical responsiveness consists in the continuous enactment and performance of the dialogue with the other. In this way, I am primarily responsive to the grand challenges of our time in my effort to innovate in a responsible way' (Blok, 2014, p. 17).

In conclusion, these ten different conceptions open different 'worlds' of responsibility and offer many possible combinations that contribute to moral innovation. All meanings of responsibility are not equally relevant for RI and we argue that the latter should connect negative understandings with more positive dimensions, in order to face the 'grand challenges' of modern technological development. Yet, the question of how these various conceptions of responsibility can be combined practically and effectively remains open. A full analysis of the relevance of all these dimensions in industrial innovation supply chains lies beyond the scope of this article, but the next section provides a few illustrations that may be helpful for further discussion on the practical implementation of RI. We focus on some of these understandings that have been less frequently explored than responsiveness, accountability or liability, i.e. task, role, capacity and virtue.

5. Moral responsibility: a polysemic and pluralist concept

As mentioned earlier, although many attempts made by RI and CSR proponents involve the key concept of responsibility, to a large extent the latter remains unquestioned. Strong constructivist analysts (mainly sociologists), expect that definitions of responsibility will emerge from processes and practices, rather than embracing a normative approach to understand the moral dimension encapsulated in the idea of responsibility (see Berthelot, 2007, for a pluralist and balanced overview of different sociological approaches). However the constructivist approach creates more problems than solutions, as definitions of responsibility stemming from the observation of actors and practitioners are unclear and do not support the cause of responsibility. Because defenders of this constructivist approach refuse to discuss the normative dimensions and requirements of responsibility, this might be called a relativistic approach. By contrast, acknowledging the polysemic character of responsibility does not evade the moral dimension of responsibility and helps to avoid an overly narrow and monistic definition, which risks becoming idiosyncratic and partial (Reber and Sève, 2006). This normative approach is meta-ethical: it goes beyond the level of applied ethics, at which a single possible position is advocated (Reber, 2011). However, choosing between the various aspects of responsibility in specific contexts remains an issue.

First, the various meanings of responsibility are not equally demanding: attributing a task to an employee or a firm, for instance, is not as challenging as assigning him/her a role since the latter can include a list of tasks. The level of responsibility assigned becomes more demanding when capacity is involved: one can achieve a task or play a role with low levels of competence or capacity as is the case for certain experiments involving PTA, where ordinary citizens are selected precisely due to their lack of knowledge about the technologies at stake. To achieve responsibility understood as capacity, innovation actors need to have specific knowledge, the ability to apply it accurately in particular contexts and a moral commitment to act in this way.

Second, the relevance of a conception of responsibility to industrial innovation differs depending on the paradigm that is applied. The idea of responsibility as a role assigned to each actor, in which various responsibilities are held and shared, seems to fit relatively well in a multi-stakeholder network conception of innovation. Innovators, venture capitalists, incubators, research institutes, policy makers, interests groups such as NGOs and end-users are given a specific role in the RI process which it is their responsibility to achieve as efficiently as possible.

Similarly, when the level of knowledge is reasonable, when certain consequences of our actions can be forecast and when the social, legal and political environment is well known and does not change rapidly, conceiving

responsibility as a task or capacity can successfully inform responsible innovation practices and governance. Assigning the responsibility for a project or for a task to somebody means that not only must the individual ensure that certain outcomes are reached (or avoided), implying repair or sanctions in the case of failure (e.g. being dismissed) but also that s/he has to engage positively to reach defined objectives. These conceptions of responsibility blur the forward looking/backward looking distinction that negative understanding of responsibility introduces, as they both involve an ability to anticipate, to account for one's own actions and to commit oneself to actions and decisions. Nevertheless, the attendant uncertainty linked to RI, and the impossibility of attributing specific actions and objectives to particular agents unambiguously will often make responsibility as a task or capacity insufficient, requiring more sophisticated interpretations such as responsiveness or accountability.

On another level, the idea of virtue, i.e. a form of excellence in achieving tasks, roles and in implementing competences in particular situations, might be invoked to increase the level of moral commitment. However, here again, complex (international) supply chains might jeopardize any evaluation of the virtue of innovation actors (CEOs, designers, researchers, engineers, end-users, etc.). For instance, would virtue be adequately assessed in identifying actors' skills through titles, prizes, books or contracts? Can excellence in the way of implementing one's aptitudes be evaluated through qualifications – especially when decision makers' competences (gained in business school) are rather distant from the core production of their enterprise (e.g. civil or chemical engineering)? If, not, how could individual virtue be best assessed? Answering these questions requires a more complex interaction between individual and collective responsibility. In innovation networks, every actor has its own responsibility, to be understood here as a role. Partners are held responsible for the consequences of their acts, for their competence and in some cases for their virtue (as when behaving in a more responsible way creates a comparative advantage). But what is also needed is that a collective and systemic responsibility, which would be one main objective of RI, emerges from individual responsible behaviour.

This brief discussion is intended as a first step towards a more effective implementation of RI: investigating the practical relevance of the various meanings of responsibility helps to select and combine them in specific contexts and can therefore inform governance and practices of innovation.

6. Conclusion

This paper has explored various meanings of the concept of responsibility analysed in moral philosophy. First, we have argued that these meanings are frequently only implicitly invoked in RI literature, which is more inclined to depict ingredients and pillars of responsibility than to question the normative dimension of it. Second, we have claimed that the idea of responsibility developed in CSR is useful to RI, in that it provides both a theoretical framework to understand networks of responsibility and a practical set of norms (e.g. ISO 26000) for the governance of innovation. However, we have also claimed that RI would benefit from a deeper analysis of the polysemic character of responsibility. In RI literature, the meaning of responsibility is sometimes reduced to responsiveness alone, while ten other understandings are also available, which have different practical relevance according to the context. Therefore, we have provided a conceptual mapping of the various meanings of responsibility and argued that RI should connect both negative and legal-oriented understandings of responsibility with more positive and prospective aspects. Finally, we have initiated an analysis of the relevance of certain conceptions of responsibility such as task, role and virtue, in the context of supply chains. By unveiling the potential and limits of these conceptions, we aim to improve the implementation of RI and help RI social actors to choose what conception – or what combinations of conceptions – best fit the context. Further work is now needed to investigate each of these meanings, their various combinations and their implications for industrial innovation.

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