

Genus, Audley and Iskandarova, Marfuga (2017) Responsible innovation: its institutionalisation and a critique.

Abstract

There is a growing body of literature on responsible innovation (RI). RI is prominent in debates and policies regarding the governance of research and innovation, particularly in the EU and USA. The paper brings together sociologically-informed institutional analysis and critical discourse analysis into a discourse-institutional perspective, which is applied to review the emergence of and scholarly contributions to literature on RI. It generates insights into the role of language use in the institutionalisation of RI from detailed analysis of a foundational text. The paper identifies evidence for the institutionalisation of RI, how this has been accomplished and by whom. The paper considers opportunities for and limitations of RI research and policy in connection with its potential to foster effective anticipatory governance of science and innovation while facilitating inclusive deliberation in society. The conclusion suggests that RI is a developing area of research and practice in which there are dominant perspectives, practices and actors, which combine to inhibit the building of a truly responsive, inclusive and reflexive approach to governing innovation.

Keywords: anticipatory governance; discourse institutions; inclusive deliberation; responsible innovation; science governance

1. Introduction

Responsible innovation (RI)¹ has become increasingly salient in policy circles. RI in the European Union, for example, is seen as an approach capable – albeit with some institutional development – of addressing ‘grand challenges’ in areas such as climate change and health (European Commission 2014; c.f. Kuhlmann and Rip 2014 on the ‘insufficiency’ of pre-existing policies and practices). As a cross-cutting theme underpinning Horizon 2020 (the EU Framework Programme for Research and Innovation) and its challenge to widen participation in ‘Science with and for Society’, RI is presented as ‘an inclusive approach to research and innovation’. This RI aims to better align research and innovation with societal values, needs and expectations.² It is typically represented as a novel approach to governance of science and innovation, characterising a move from ‘risk governance’ to ‘innovation governance’ (von Schomberg 2014). This shift entails governing innovation through early ‘upstream’ interventions rather than ‘downstream’ monitoring and ‘correction’ of interventions ex post. It means moving away from approaches geared towards ex ante calculations of the risks and benefits associated with inherently uncertain decisions about technology, to one more concerned with broadening processes of decision-making to realise ethically acceptable and societally desirable innovation (von Schomberg 2013).

RI is identified with a shift of emphasis from ‘shaping technology’ on the supply side and through better design, to ‘shaping innovation’ (Grunwald 2011), with greater attention to the interaction of technology development, societal needs and the rules and processes governing this relation. A frequently cited definition states that: “[r]esponsible research and innovation is a transparent, interactive process by which societal actors and innovators become mutually

¹ Here, ‘RI’ refers both to ‘responsible innovation’ and ‘responsible research and innovation’.

² <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/science-and-society>

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 2012: 50).

Owen et al. (2013) articulate four dimensions of RI: (i) anticipation; (ii) inclusive deliberation; (iii) reflexivity; and (iv) responsiveness. Although closely interlinked with future-oriented concepts of foresight, horizon-scanning and scenario-building, the idea of anticipatory governance in RI is often presented as a step forward in governance of technology and innovation, which should not be confused with much-criticised approaches to forecasting or prediction of impacts of technology (Guston 2013). It includes governing activities that are more broadly distributed across numerous actors, extended through society through inclusive deliberation. Reflexivity is another prerequisite for responsible, responsive and accountable research and innovation. It means ‘holding a mirror up to one’s own activities, commitments and assumptions’, being aware of the limits of knowledge and the potential existence of other framings of an issue (Stilgoe et al. 2013). Responsiveness ‘requires a capacity to change shape or direction in response to stakeholder and public values and changing circumstances’ (Stilgoe et al. 2013), explicitly linking innovation to societal challenges and public interest. These dimensions must be integrated, mutually reinforcing and applied in an iterative manner for the proposed RI framework to be realised in practice. Thus understood the dimensions provide criteria with which to assess the institutionalisation of RI.

RI-related ideas date back at least to the 1930s, based on concerns about the relationship between science and society and the responsibility of science and scientists (Bernal 1939;

Rose and Rose 1969). Such concerns were reflected in, but not confined to, anxiety about the development and use of nuclear technology for generating electricity and for military application. Moreover, contemporary researchers draw on well-known concepts and activities concerned with potential consequences of research and innovation (e.g. Stilgoe et al. 2013, Grunwald 2011, von Schomberg 2014), informed by a variety of disciplinary perspectives, such as science and technology studies (STS), philosophy and political science. Relevant concepts and practices include technology assessment (TA), science governance, risk governance, (engineering) ethics, public and stakeholder engagement, anticipation, foresight and future studies, each having their own rationale, strengths and limitations. Von Schomberg (2014) points to governance principles, e.g. the precautionary principle firmly embodied in European policy, as inherited by RI from previous cases on innovation and technology governance.

The argument has been made that previously known approaches cannot satisfy all of the expectations connected with the governance of science and technology although they variously provide knowledge, expertise and a methodological toolbox for RI research and policy communities (Grunwald 2011). The major novelty and practical relevance of RI is in integrating existing approaches and in making an explicit link between innovation and responsibility (Grunwald 2011, Grinbaum and Groves 2013, Owen et al. 2012; 2013). This means that existing responsibilities need to be addressed as a whole, framing RI as a responsibility for society at large, with closer attention to societal context and a broader spectrum of actors capable of reflecting on their own values and research and innovation-related responsibilities (Grunwald 2011; Wynne, 2011).

The paper critically reviews existing literature on RI. The paper argues an approach informed by a discourse-institutional perspective can insightfully contribute to building an understanding of the institutionalisation of RI research and practice. In doing so such an approach may help to probe the ‘carriers’ and practices of RI and the implications of these for anticipatory governance of science and innovation for embracing diverse but relevant perspectives and actors which might render such governance effective and fair. Accordingly, the paper addresses the following research questions:

1. To what extent, why and how has responsible innovation achieved greater institutionalisation?
2. What are the dominant conceptions and concerns of responsible innovation research and practice?
3. What perspectives or actors are marginalised in RI discourse, and why?

The paper has the following structure. Section 2 outlines the discourse-institutional methodology and the more specific methods employed to critique and to review RI. Section 3 specifies how this approach is applied to critically review the emergence of RI research and policy. Section 4 closely analyses the text of a foundational contribution on RI to generate insights into its institutionalisation, identifying some matters of concern arising from this for anticipatory, inclusively deliberative, responsive and reflexive governance of science and innovation. Section 5 situates these concerns in a critique of pervasive social structures, which are implicated with conventional practices for exerting control over the future and regulating science and innovation. Section 6 is a conclusion summarising the work of the paper and pointing to implications thereof for the institutionalisation of RI.

2. A methodology and methods for critically reviewing RI

The paper suggests that debates about the institutionalisation of RI may be helpfully informed by drawing on literature on ‘discursive-institutionalism’, some of which has been invoked by

researchers of innovation, environmental policy, and science and technology studies (Hajer 1993; Hajer and Versteeg 2005; see also: Author 2016; Schmidt 2010). Schmidt (2010) considers ‘discursive institutionalism’ to be an umbrella term encompassing a range of views on the exchange, communication and legitimation of ideas in the political sphere, one which represents a fourth type of neo-institutional approach. However, a fundamental distinction may be made between (e.g. Schmidt’s 2010) discursive institutional approach and the discourse – institutional perspective adopted here, which explicitly brings together a critical view of discourse with sociologically informed institutional analysis. The critical orientation of the approach puts centre stage the domination or marginalisation of certain actors or ideas, highlighting how this is institutionalised. More than a merely discursive approach, a discourse-institutional perspective addresses how institutional phenomena come to be objectivised and experienced as ‘real’. More than a merely institutional approach, a discourse-institutional perspective recognises the importance of language and subjectivity to prevailing institutions and institutional change.

Central to the discourse-institutional approach is the idea that discourse constitutes thought and other phenomena which frame the possibilities for social action. The approach focuses on the language and related structural arrangements which constitute and institutionalise social relations. The paper argues that it is necessary to examine *critically* language-related phenomena which partly create and reproduce social relations (and possibly transforms them). However, it addresses broader and unequal relations within its analysis of ‘language and power’, than might be the case with a narrower conception of language based on minute linguistic analysis (Fairclough 2001). This critical approach is associated with the work of Fairclough (2003; 2010), who attempts to unravel the workings of contemporary capitalism. The argument is that such a view can help to understand patterns of dominance, inertia and change in contemporary societies. It is thus an approach which fits well with an aspiration to

understand more clearly the nature and effects of institutionalisation and sources of possible institutional change.

In relation to ‘institutions’ it should be made clear that one is not employing this term to refer merely to political organisations, as is often the case in literature advocating the need for ‘institutional change’ or new policy arrangements, in relation to improving the governance of science and innovation (c.f. Author 2014). Rather, the reference is to institutions as ‘rules’ (Scott 2008). Thus institutions are understood to be regularities in social life which are held in place by complexes of formal or regulative, normative and cultural-cognitive rules, and the compliance mechanisms which underpin them, but which are subject to change. These rules are inter-related so that, for example, legislation and legal sanctions enforcing them are only effective if they are accorded an assumption of credibility among those who are intended to be disciplined by them. Legitimacy is ‘carried’ by interacting artefacts, relational networks, routines, language and symbols. Whereas previous work emphasised institutions as having inertial properties and stability in social life, later contributions focus on what allows new institutions to become embedded and ‘old’ ones to be disrupted (Greenwood and Suddaby 2006). Understanding institutions in this way, the paper considers the potential insight that might be gained from developing a complementary approach which bridges a critical approach to discourse analysis of responsible innovation (c.f. Li et al. 2015; Stahl et al. 2014 on the role of fiction and narratives in prompting thinking about the ethics and desirability of new technologies) with a concern to fill the ‘institutional void’ regarding the structures and rules available for governing emerging technologies responsibly (Hajer 2003; Stilgoe et al. 2013).

From a discourse-institutional perspective it may be seen that language and other discursive phenomena are constitutive of and constituted in the making, enforcement and carriage of prevalent, nascent and putative institutions (Author 2016). Those who author texts potentially

have power *in* the discourse and may contribute to building power *behind* the discourse (e.g. the institutionalised conventions and incentives/sanctions which embed RI, c.f. Fairclough 2001). The critical discourse aspect of discourse institutions involves the analysis of three elements: (a) text; (b) discursive practices and (c) social practice (see Figure 1). These require the analysis of foundational ('authentic') texts, 'orders' of discourse (genres, styles, types of discourse) and strategies of argumentation deployed, all understood in the context of deeper social structures. Authentic texts include certain statements made about RI, for example by academic authorities, governmental and other actors. In terms of discursive practices, genres are the 'where' and 'how' of the conduct of RI through which its meaning, practice and significance are conveyed (venues, the spoken or written word, online, diagrams etc.) and styles refers to the identities of who does or doesn't do the 'it' of RI. Social practice refers to social structures which govern sets of possibilities within which social events occur, and texts are produced and consumed. The relation between 'texts' and social practice is mediated by discursive practices and texts are partly shaped by and are one factor in shaping social practice, albeit that the relation between the two is not a simple causal one.

The dimensions of RI discussed above provide criteria with which to assess critically the institutionalisation of responsible innovation. Such appreciation draws on Habermas' (1984) ideas regarding the circumscription of the public sphere in political life and how 'ideal speech situations' may be undermined in practice. Habermas identifies requirements for open, 'rational' and 'undistorted' communication in social and political life, which include: mutual understanding among actors; recognition of the legitimacy of other actors; and equal opportunity of the actors to take part in discussions without unreasonable or strategic behaviour. However, following Foucault (1972) a critique of RI may also address the 'genealogy' of responsible innovation, focusing on the capacity of actors to take part 'dissensually' in the creation and reading of texts, and the sense of self they derive from

being able to do so. This contrasts with Habermas' focus on consensus arrived at through good communication producing agreement on the 'better argument'.

[FIGURE 1 ABOUT HERE]

2.1 Reviewing RI research

The paper adapts the approach taken by Greenhalgh et al. (2005) to reviewing a cognate research area, which comprises five overlapping rather than sequential phases: i) planning; ii) search and mapping; iii) analysis; iv) synthesis; and v) reflection and recommendation. In the first phase the researchers drew up a plan for conducting and reporting on the review of RI research. This involved making decisions about the purpose and scope of the review and in relation to its conduct. Hence the scope of the review is restricted to research explicitly addressing RI, i.e. contributions containing the term in their title. Other bodies of work on, for example, public engagement are relevant but have their own voluminous and diverse literature, which would not be feasible to review within the space constraints of this article. Also, the authors agreed that a review informed by a discourse-institutional perspective, is well adapted to the task of analysing critically the prevalent as well as neglected perspectives, actors and processes implicated with RI research.

In phase two, the authors conducted title searches for outputs published in all years up to the end of 2015, employing the search term 'responsible innovation'. These were conducted within a 24-hour period, on the Google Scholar website (24 March 2016) and on Web of Science (25 March 2016). It was felt that using this search term was justified as it would also capture contributions containing the narrower term 'responsible research and innovation' in their title. Duplicates, non-English language and out of scope publications were removed from each of the two lists of results. Then duplicates across the two lists were removed and the results of the two searches merged. The authors read and re-read available full text of

papers, book chapters and other publications considered relevant following discussion between them; in addition, they followed up citations within publications and relevant work suggested by colleagues. This enabled an initial review and mapping of RI literature to be done. An inductive approach was employed to coding working from the text of the contributions. This allowed the prevalence of empirical research and prominent disciplines, foci to be identified. Subsequently, selective coding (Böhm, 2004) helped to identify dominant themes in empirical research, on the basis that such an approach requires the researchers to ask themselves what story the data tell about a selected core category, i.e. 'responsible innovation'. The authors worked individually then compared their analyses, producing agreement on the foci and thematic areas covered in empirical research on RI.

In the third phase, the search results and policy-related phenomena were reviewed in the light of the DI perspective outlined above. Critical discourse analysis of key texts is helpful to identifying the processes and effect of institutionalisation of responsible innovation, so as to appreciate better its conceptualisation and application in research and practice. Thus the authors identified and conducted a critical discourse analysis of one core text central to the recent emergence of responsible innovation. In terms of phase four, synthesis, the authors reconsidered common conceptions, concerns and themes of research on RI to identify foci or themes missing from or underplayed in RI. Carrying out the fifth phase of the review entailed reflection by the authors on the achievements and shortcomings of RI and implications for future RI research and practice. These last two phases are discussed in section 5, in relation to macro-social phenomena, and in the concluding section of the paper.

3. Taking stock of research on responsible innovation

The Web of Science search showed that in all years up to the end of 2005 five outputs were published containing the term 'responsible innovation' in the title but in the period 2006-

2015 there were 75 (Table 1). The earliest was a paper in Nature (Anonymous, 1972). A similar search using Google Scholar produced five results up to 2005, one of which is erroneous, and 238 results from 2006-2015 (Table 2). Combining the two searches and removing duplicates and across them produces a corpus of 269 results, the distribution of which is shown in five-yearly periods in Figure 2 and by category of publication in Figure 3. The rise in the number of articles with responsible innovation in the title has been particularly remarkable in the period 2011-2015. Indeed, over ninety per cent of the research on RI has been published since 2011, with another 5% having been published in the five years up to the end of 2010. 61 publications reported on studies involving the collection of original empirical data (about 23%). Editorials and ‘perspective’ pieces in publications such as Journal of Responsible Innovation make up 6% of publications in our sample and are prominent in setting the agenda for RI research. Looking at the ‘home’ institution of the authors and geographical focus of the content of publications (where this is identified in the contribution), it is apparent that responsible innovation is predominantly a European and to a lesser extent, North American phenomenon. The number of contributions which focus on other geographical regions is around 6% of the total number of articles and a similar proportion of contributions have co-authors from non-European or North American research institutions.

[TABLE 1 ABOUT HERE]

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[FIGURE 2 ABOUT HERE]

[FIGURE 3 ABOUT HERE]

The empirical research on RI has been concerned primarily with the following foci:

- RI as an experiment in the governance of science (Owen and Goldberg 2010; Macnaghten and Owen 2011; Fisher and Rip 2013);
- Science actors' views of RI (Pandza and Ellwood 2013; Fonseca and Pereira 2013; Macnaghten and Chilvers 2014; Campa et al. 2014; Stahl 2013, Wickson and Carew 2014);
- The perceptions of RI held by lay actors (citizens, consumers, schoolchildren) (Copeland and Hasell 2014; Gorghiu et al. 2015; Macnaghten and Chilvers 2014; Parkhill et al. 2013);
- Politics in and of deliberation; limits to inclusive deliberation (de Bakker et al. 2014; Chalmers et al. 2014; Reinsborough and Sullivan 2011, 2014; Van Oudheusden 2014);
- The application of RI in business or 'low tech' settings (Armstrong et al. 2012; Asante et al. 2014; Muniesa and Lenglet 2013);
- The development and dissemination of tools for implementing RI (European commission-funded Framework Programme 7 'RRI Tools' and 'FLAGSHIP' projects);
- The monitoring and dissemination of RI practices (FP7-funded 'RESPONSIBILITY'; 'Res-AGorA'; 'GREAT' projects [Gianni 2014]) and governance frameworks (FP7 funded 'ProGReSS' and 'SYNERGENE' projects).

Initially, empirical research on RI focused substantively on nanotechnologies, biomedical technologies, geoengineering and information technologies, and public engagement and dialogue processes. Over time the foci of RI research has broadened in scope to include: adoption or implications of responsible innovation for organisations (Pavie et al. 2014)

including academic spin-offs (Scholten and van der Duin, 2015) and SMEs (Halme and Korpela, 2014); the implementation of RI in the finance (Armstrong et al. 2012; Asante et al. 2014, Muniesa and Lenglet 2013), energy (Shortall et al. 2015) and automobile sectors (Wodzisz 2015); port development (Ravesteijn et al. 2014) and security technologies (Menevidis et al. 2011); and strategy-making in universities. The geographical locus of empirical studies has begun to spread, especially to Asia (e.g. China, India, Indonesia, Malaysia, Vietnam, c.f. Macnaghten et al. 2014).

The empirical research on RI is informed by thinking from diverse disciplines (e.g. life sciences, science and technology studies, engineering, computing and information technology, innovation, sociology, psychology, politics, and ethics). A range of research methods and methodologies have been employed, within as well as across empirical research. There is much use of participant observation, ethnographic, case study and other qualitative approaches. The employment of quantitative methods is small in comparison. The nature, ‘problems’ and significance of RI has been characterised in a number of different ways, and this heterogeneity defies easy synthesis regarding the findings of the work. However, there are certain dominant and pervasive underpinning conceptions, rationales and assumptions that direct RI research. The dominant discursive themes frame RI as: the control of risk and uncertain futures; open science; supporting innovation, ethical research; and struggling to realise inclusive deliberation. The analysis undertaken below highlights the role of language and other institutionalising factors in spreading and embedding the RI research and policy agenda outlined above.

4. Discourses and the institutionalisation of responsible innovation

In this section the paper applies the discourse-institutional perspective to account for the institutionalisation of RI over the past decade. The role of language is examined and

exemplified in relation to this institutionalisation, focusing on language use in a selected foundational text of RI, and the manner in which these are consumed and produced, thus facilitating the circulation and carriage of ideas and practices connected with RI. Particular attention is paid to the ways in which text and discursive practice constrain the purposes, activities, and sites of RI, and the relations and identities of protagonists therein, potentially structuring contributions made to debates about RI (Fairclough 2001). Following this, section 5 presents a discussion reflecting on the implication of wider social structures for the selected text and discursive practice of RI.

4.1 Text

The above shows that institutionalisation of RI is carried by, for example, the growing number of journal articles on the topic, a significant number of which appear in the recently founded Journal of Responsible Innovation. Certain foundational (i.e. early and/or much cited) ‘texts’ have played a central role in promoting and diffusing not only RI but a particular conception of it. Texts authored by either Owen and colleagues or by von Schomberg occupy eight of the top ten most cited works listed in the Google Scholar search conducted by the authors. These include the book chapter and the edited volume in which it appears by Owen et al. (2013), the paper by Stilgoe et al. (2013) and several contributions by von Schomberg (2011b; 2012; 2013). Section 6 of a book chapter by von Schomberg (2012), which contains his much-quoted definition of responsible innovation, is the selected text on which the analysis to follow is based. It proposes a ‘working’ definition of ‘responsible research and innovation’ as does the draft version of the chapter presented in von Schomberg (2011a; see also 2011b), though subsequent publications replace ‘working’ with the more assertive ‘proposed’ (von Schomberg 2013; 2014).

In terms of its representation of the social world, von Schomberg (2012) appeals to technology assessment, technology foresight, regulation and ethical review. There is a naturalisation concerning the requirement for ‘ongoing risk assessments’ for which ‘[i]t goes without saying’ (p. 50). Further, “Responsible Research and Innovation would not need any new policy guidelines, but simply would require a consistent application of the EU's fundamentals to the research and innovation process reflected in the Treaty on the European Union” (p. 51).

Relations among potential participants feature prominently in the text, which conceives of RI as a ‘transparent, interactive process’ (p. 50), involving ‘societal actors’ *and* (our italics) ‘innovators’ who ‘become mutually responsive to each other’ (p. 50). Innovators are thus placed outside of and different from ‘societal actors’. von Schomberg emphasises the benefit of ‘[e]arly societal intervention’ and ‘ongoing public debate’. He contrasts ‘ongoing public platforms’ with ‘one-off public engagement activities with a particular technology’ which it ‘should replace’ (p. 58). Public debate on the ‘normative baselines for acceptable risks or acceptable infringements of privacy rights’ is seen as having ‘ideally...a moderating impact on “technology push” and “policy pull” of new technologies’ (p. 58). The specific form and possible identities or roles of participants in public debates is addressed rather implicitly. The text does not specify the grounds for collective deliberation and response or how one would know that it is or is not occurring. More fundamentally, like other contributions to RI, the selected text struggles with how to loosen deep-lying constraints on the realisation of democratic deliberation in liberal democracies (see: Mouffe 2000, Löwbrand et al. 2011, on the ‘democracy paradox’).

Assumptions are made about the nature of scientific research and technological change. For example, there is an opposition of ‘social scientists’ and ‘natural scientists’ (p. 57). There is reference to the role of ‘social scientists and/or ethicists’ engaging in ‘laboratory

engagement’, in ‘research teams of natural scientists’ (p. 57). The role of social scientists is to moderate the laboratory practices of natural scientists (p. 57). On the matter of technological change one notes the collocation of ‘technological’ with ‘advance’, which occurs several times in the text (e.g. three times on p. 50; p. 57; p. 58).

The chapter is directed to a reader presumably operating in a policy, research, NGO or corporate environment related to the issues being discussed in the text, rather than a lay reader unfamiliar with terms such as ‘normative anchor points’ or the provenance or content of European Commission codes of conduct (e.g. for nanotechnology research or ICTs). The text is mainly declarative (giving information) and imperative (suggesting or obliging action) in tone. It uses expressive and relational modalities, i.e. there is a tendency to make categorical authoritative-sounding statements about truth in an assertive way, and frequently uses ‘should’ or ‘should not’ rather than ‘may’ or ‘might (not)’ regarding what is required of others in the name of doing RI. The text is mostly written in the third person, as are many texts in the research/policy domains, so the writing comes across as presenting arguments with an air of detachment and scientific objectivity. However, there is occasional use of the first person as in ‘I propose the following working definition for responsible research and innovation’ (p. 59) and ‘I see two interrelated dimensions’ (p. 59). The author of the text also uses the more inclusive ‘we’, ‘us’ and ‘our’, which smoothes over possible dissent, as in the following examples: ‘We have, up till recently, possibly assumed that...[common European] values cannot be applied in the context of research and innovation’ (p. 51); ‘the quest for assessing and foreseeing [societally beneficial] impacts gives us the opportunity to define those impacts along the...three pillars of the United Nations objective of sustainable development’ (p. 59); and in framing the role of RI as being to allow for ‘proper embedding of scientific and technological advances in our society’ (p. 50).

4.2 Discursive practice

The selected text draws upon various genres which implicate why, how and where RI started to become enacted in the EU. For example, the chapter is informed by European Commission and EU policy, corporate R&D activities and the practice of and research on technology assessment in and for society. Beginning with the genre of written policy documents and in relation to the EU, the text draws on policies and approaches to impact assessment of new technologies, such as its ‘framework for better regulation’ (p. 40), and normative targets [that] have been democratically agreed upon’ in the Treaty on the European Union’ (p. 42); the precautionary principle which is ‘enshrined in the 1992 Maastricht Treaty’; directives on genetically modified organisms and on chemical substances; and the European Commission-recommended code of conduct for nanoscience and nanotechnologies research (p. 53). Here one may note the inclusion of codes of conduct for the development of new products (p. 53), and formal or normative rules for ‘ensuring market accountability’ such as standards, accreditation and certification (p. 56). The selected text draws on printed publications from research projects, such as European Commission-funded projects such as ‘DEEPEN’ (p. 45) (Macnaghten et al. 2010).

The text draws on online media, e.g. rules appearing on the website pertaining to the call for and assessment of research funding proposals to the EPSRC, a research council in the UK, according to which applicants have ‘to report the wider implications and potential risks [of proposed research]’ (p. 50). It also draws on research project websites, for example the European Commission-funded projects ‘ETICA’, on the governance of emerging information and communication technologies (p. 57) and ‘NANACODE’, on codes of conduct relating to research and innovation in nanotechnologies.

The genre of the research workshop offers opportunities for face-to-face (i.e. non-mediated) interaction and is pertinent to the production of the selected text and consumption of both this text in its published form and of a draft thereof. For example, two pivotal workshops were held in May 2011. One was a workshop held in Brussels at which an appeal was made by representatives from the European Commission for help from academics and others to define responsible innovation. Later in the same month a paper by von Schomberg (2011a), containing his working definition of responsible innovation, was circulated at a workshop on responsible innovation (Owen et al. 2012). This paper was eventually published as the selected text (von Schomberg 2012).

The selected text draws upon genres of public engagement, such as technology assessment approaches adopted by the Rathenau Institute in the Netherlands, which are quoted – in the context of enacting ‘co-responsibility’, and following Van Est (2010) - as being capable of ‘*seducing* actors to get involved and act’ (p. 58, our italics). Practices in the USA also inform the text, for instance the ‘Nanofutures’ project in relation to public engagement and the ‘deliberative foresight’ approach (p. 47). The text gives examples of corporate collaboration with NGOs or civil society, thus demonstrating a shift from risk to innovation governance. One is BASF’s establishment of ‘a dialogue forum with civil society organizations...’ (p. 53); another concerns collaborative arrangements between Unilever and the World Wildlife Fund in relation to setting standards for sustainable fishing (p. 56). The text does not say how open the dialogue forum is nor specify the nature of the Unilever/WWF collaboration in relation to possible degrees of mediation or quality of communication/dialogue among participants. However, the text notes the success of the arrangement in effecting the accountability of a significant commercial actor in the field of fishing.

4.3 Styles: identities, values and social relations

Here, the relation of the author of the selected text to others and issues of identity are of interest. The author is able to write authoritatively – at the time of the above-mentioned 2011 workshops von Schomberg was already a champion of RI based in the Directorate General for research and innovation at the European Commission. He had (and has since) produced a number of other papers, book chapters and edited collections on RI for academic and EU policy audiences (2010; 2013; 2014). Similarly, the text refers to the requirements of national research funding authorities, such as the EPSRC in the UK, and the US National Science Foundation, which ‘makes assessment of [research] proposals in terms of “broader impacts”’ (p. 41).

Value commitments are represented in the text discussed above but also in other texts and discourses upon which von Schomberg draws. The values and priorities of the author the text are present in references to technological ‘advances’ and the ‘marketable products’ of innovation but also in relation to the commonality of ‘European values’. He argues for continual public debate which is ‘needed for the legitimacy of research funding and particular scientific and technological advance[s]’ (p. 58) and which should ‘ideally [establish] a link with the policy process’ (p. 58). The text connects the discourse of responsible innovation with texts and discourses relating to global debates and policies pertaining to international climate change, sustainable development and public health. There are specific examples, including the UN definition and pillars of sustainable development (p. 51 and p. 59) and the 2009 Copenhagen climate change summit. These are touchstones for von Schomberg in elaborating RI in the context of ‘common European values for promoting public policies’, referred to by ‘various top officials’ (p. 51). Thus he considers the UN definition of sustainable development to provide a basis for RI as embracing social, environmental and

economic objectives. The Copenhagen summit is noted for the work of the US Environmental Protection Agency in arguing for the connection between greenhouse gas emissions and damage to public health. The following section discusses the implication of deeper social structures and relations with discursive practice and the focal text, to shed further light on the institutionalisation of responsible research and innovation.

5. Responsible innovation: legitimacy, institutionalisation and social practice

The orientation towards societal challenges and the pursuit of positive or ‘right impacts’ of innovation, for example in the EU Horizon 2020 programme, could be seen as an attempt to legitimise European policy on research and innovation by invoking responsibility (von Schomberg 2014). RI in EU policy has been justified as a ‘design’ approach that can potentially ensure desirable and acceptable research and innovation outcomes (Stahl 2013), an example of the deployment of a ‘rationalisation’ legitimisation strategy rooted in utilitarian arguments. These outcomes are defended as being consistent with ‘common’ European values (von Schomberg 2011a; 2011b; 2013; 2014) – the argumentation in this case being based on ‘authorisation’, referring to the democratic authority of the European Union. The moral justification for RI in the selected text emphasises the need to address the ethical dimensions of research and innovation in order to co-produce right impacts with improved insights ex ante into the ‘ethical acceptability’ and societal ‘desirability’ of new products. As discussed below, these principled, proactive and participatory bases of RI have been challenged, calling into question the institutionalisation of RI in a manner consistent with the four dimensions of RI (Owen et al. 2013) outlined in the introduction to the paper.

A critical sociological perspective recognises immanent institutions of contemporary societies, and their role in societal inertia but possibly also as sources of transformation.

Taking the example of EU research funding policy, the institutionalisation of RI is implicated with the design of tools, formal rules and the establishment of principles or criteria with

which to guide it. It continues the modernist search for elusive ‘control’ over uncertain or risky science and innovation futures, within a paradigm of technology assessment and ‘choice’. This is an enduring and pervasive way of viewing the governance of innovation in advanced capitalist societies. It has a longstanding history which predates but still informs the conception of and approaches to responsible innovation, and is associated with the problems and methods of anticipatory technology assessment. Indeed, utilitarian approaches have been traced back to the emergence of rules and techniques for conducting risk appraisal in economics and management in the mid-19th century. This development itself represents a consequentialist turn within social science which emulated how, in the Reformation, society at large and science in particular had begun to identify virtue in successful attempts to transform the world. The focus turned to future outcomes rather than in the application of customary rules of the past, as in the ancient period (Groves 2015).

Thus in RI research and policy there is a preoccupation with both ‘promises’ made of technologies and the search for processes which may elicit ‘right impacts’ (von Schomberg 2013). Many contributors, including Owen et al. (2013) and Stilgoe et al. (2013) frame this in terms of transcending the Collingridge (1980) ‘dilemma’. Here, the need and ‘problem’ for RI concern how to govern technology responsibly ‘upstream’ when little knowledge is available about possible serious ‘downstream’ consequences for society, though when such information does materialise taking remedial action becomes slow and costly (Collingridge 1980). These may take various forms of socio-technical imaginary (Jasanoff et al. 2007) be it of progress and economic competitiveness, technology as a ‘fix’ for grand challenges, consumer choice or decentralisation, or local sustainable development (Boxenbaum et al. 2012).

In Nordmann’s (2007; 2014) critique, RI may be ‘confused in what it wants to achieve’ if it requires the anticipation of ‘a non-trivial future’. Such a ‘technovisionary discourse’ is

neither necessary nor desirable; in any case responsible innovation is an ‘actor’s term’, one which should be the subject of ‘conceptual and historical analysis’, and self-reflection on the part of its proponents. Specifically, this relates to enactment of anticipation in RI, which prompts scientists and innovators to ask ‘*what if...questions*’ [italics added]. Here, scientists and innovators are identified as requiring prompting to reflect on important questions about innovations that they might not otherwise consider. However in the selected text and other landmark contributions it is also implied that their ‘creativity and curiosity’ will not be ‘stifled’ (Owen et al. 2013: 39) and that RI will not become another ‘hurdle’ to innovation (von Schomberg 2013). Nordmann (2014) insists that anticipatory governance may be ‘promoted’ by a ‘regime of vigilance that is informed by historical experience’. Such an approach emphasises ‘imagination’ of ‘what might happen in the world as we know it’ rather than speculation regarding ‘futures’ (Nordmann 2007), though it fails to specify how this is to be realised in practice (Selin 2014; Wilsdon 2014).

A critique of RI points to the marginalisation or absence of a genuinely inclusive or ‘bottom up’ approaches to democratic deliberation. Such critique points to deeper roots of prevailing conceptions underpinning RI in research and policy inherent in social practice. Some contributors draw attention to notions of (possibly non-legalistic, non-contract-based) ‘care’ (Groves 2015), as an alternative paradigm to the dominant worldview of punctual choice in prevailing approaches to responsible governance of innovation. In the latter, institutional regulatory and normative rules and ethical principles for governing risks or uncertainties derive from an imaginary in which governance is positioned as external to the activities of technoscience. However, it suggested that rooting governance in practices of technoscience and innovation and the relations among constituents therein affords a more humble process, capable of escaping the ‘double-bind’ in which society has to rely upon conventional tools and processes of (responsible) innovation which it cannot ‘fully’ trust. Rather, ‘care’ requires

the creation of new institutions and related practices which ‘maximise the promotion of agency among publics to shape the social priorities which guide innovation’. This is argued to be preferable to (formal) rule- and principle-based approaches to RI which amount to ‘re-tooling regulation in order to reduce uncertainty for citizens imagined as consumers’ (Groves 2015: 331). The suggested alternative relies upon care for others and connected relationships with others through which human needs are ‘always constructed in the process of meeting them in ways that are emotionally and symbolically constitutive of individual and group identities’ (Groves 2015: 328).

To underline the point, the ‘bottom up’ and transformative potential of RI, stands in contradistinction to what is seen as a scientific or top-down, expert-driven approach (see Hankins and Grasseni 2014; Sutcliffe 2011; c.f. von Schomberg’s definition of RI). Related strands of RI research are concerned with the perceptions of lay actors and lack of inclusivity of deliberative processes (Macnaghten and Chilvers 2014; Reinsborough and Sullivan 2011) and ‘information asymmetries’ between industry innovators and citizens (De Bakker et al. 2014).

Proponents of RI are concerned to point up the significance of just and democratic deliberation to responsible innovation. However this aspiration to inclusivity is undercut by an orientation towards ‘inviting’ the participation of publics and wider stakeholders – an approach which in other literature has attracted criticism (e.g. Chilvers 2010). Thus ‘publics’ and ‘diverse stakeholders’ are identified as needing to be invited and listened to in ‘collective deliberation’, though not decisively proactive therein. In von Schomberg’s (2011a; 2011b; 2013) much-quoted formulation ‘innovators’ are to become responsive to ‘societal actors’; an indirect reference is made to science and innovation funding and funders but there needs to be more detailed consideration of how this responsiveness among actors might be realised in a properly inclusive manner.

6. Conclusion

The paper offered a critical account of the institutionalisation of responsible innovation, an academic sub-field and arena of policy and practice which has grown significantly in prominence recently. Noting that antecedents to RI were concerned about the role of science in society and ‘impacts’ of new technologies, the paper reviewed literature published with specific reference to responsible innovation (including ‘responsible research and innovation’). The paper applied a discourse-institutional approach to the analysis of a selected foundational text on RI, to highlight the role of language in arguments for and in the normalisation of the practice of responsible innovation. In doing so it demonstrated the potential of such an approach to shed light on the ‘legitimacy’ and ‘authority’ gaps in RI (Stilgoe et al. 2013), understood here in terms of what or whom is present and whom or what is missing as RI achieves wider institutionalisation.

The paper contributes to debates concerning the improvement of the governance of science, technology and innovation. These have long been associated with questions about how to realise better technology in, with and for a better society (c.f. Collingridge 1980) and more recent ones about declining trust in science and expertise and how to engage citizens in more open processes of science governance. In amongst these manifold anxieties are visions of possible futures which various participants and non-participants hold, not only relating to the promise and ‘impacts’ of science and innovation but also to the governance processes entailed in co-producing them.

Cast in the terms of the research questions stated earlier and informed by the literature search and analysis of the selected text carried out above, the paper has shown that: a). there is incomplete institutionalisation of RI but it has acquired a higher degree of legitimacy (with certain stakeholders) in the EU and US, than in other parts of the world. This pervasiveness in

the EU/US owes much to the concerns of policy-makers and research funders regarding the need to secure desirable outcomes from scientific research and promising innovations, anticipating societal expectations and ‘impacts’, and bridging science and society. Central to this partial institutionalisation are networks and related products (texts) of academic and policy contributors, which act as ‘carriers’ of RI and in which discursive practice is integral. Texts include a research literature which has mushroomed in the 2010s, foundational papers, books and book chapters, and the policies of research funders and policy-makers; b). there are widely, though not universally accepted, normative conceptions of RI that see it as supportive of innovation, proactive management of risk/uncertainty and gaining public acceptability for or overcoming resistance to innovation. These are not fully hegemonic; the need for RI is not unquestioned. Thus there is a branch of RI concerned with exploring limits to inclusive deliberation though RI still is not typically practised as such, and is in any case a preoccupation of the global north; and c). commonly practised discursive genres and styles variously marginalise scientists, social scientists and citizens, through which they are identified as passive, lacking in influence or involved in awkward relationships (Jirotko 2015). Prevalent discourses emphasise a focus on ‘choices’, future outcomes and the quest for ‘right’ impacts, which eclipse relations of care (Groves 2015)

Reflecting on discourse institutions of RI, one may speak of a deficit in the politics of responsible innovation, whereby EU RI research and policy, for example, may have exacerbated rather than resolved the democratic paradox (Lövbrand et al. 2011; Mouffe 2000). Future contributions to RI need to be mindful that they do not aggravate this paradox, if RI is not to engender illegitimate innovations that its proponents and society more broadly might wish to avoid. A step forward may be to build on remarks by Stilgoe et al. (2013) regarding the realisation of input (‘process’) and output legitimacy but informed by a fuller appreciation of Collingridge’s (1980) own incremental approach to resolving the Collingridge

dilemma. Legitimate RI processes require researchers and policy makers to recognise limits to deliberative democracy in RI, by addressing the inhibiting discursive effects of RI practices and social structures in modern societies. Some recent developments in RI have recognised this, and several European Commission-driven initiatives have been identified in the paper, which aim to create an inclusive RI community, such as RRI Tools and the Observatory for International Responsible Research and Innovation Coordination both set up to create spaces and to provide platforms for more inclusive collaborative developments of RI, and the European Research Area (Reillon 2016). Similarly, the European Commission's European Open Science Policy Platform has the potential to contribute to development of the inclusive deliberation aspect of RI and democracy of science. Such projects hold the promise of building the reflexive capital aimed at by Owen et al. (2013) by elaborating and remediating constraints on accessing the networks in which the assumptions, meanings, norms and practices of RI are contended. They may enable the (co-)production of innovations which impose fewer costs on affected constituencies than does 'top-down' RI governance, though it is not possible to say with confidence that they will.

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References

Anonymous (1972). Who will be responsible for innovation? *Nature*, 239: 181–182 (22 September)

Armstrong, M., G. Cornut, S. Delacôte, M. Lenglet, Y. Millo, F. Muniesa, A. Pointier and Y. Tadjeddine (2012). Towards a practical approach to responsible innovation in finance: new

product committees revisited. *Journal of Financial Regulation and Compliance*, 20, 2: 147–168.

Asante, K., R. Owen and G. Williamson (2014). Governance of new product development and perceptions of responsible innovation in the financial sector: insights from an ethnographic case study. *Journal of Responsible Innovation*, 1, 1: 9-30.

Author (2014)

Author (2016)

Bernal, J.D. (1939). *The Social Function of Science*. Routledge. London.

Böhm, A. (2004). Theoretical Coding: Text Analysis in Grounded Theory. In: U. Flick, E. Kardorff and I. Steinke (eds.) *A Companion to Qualitative Research*. London: Sage, 270-275.

Boxenbaum, E., B. Laurent, J.-F. Guillemoles, N. Lermant, C. Le Renard-Lecoite, M.

Billard, F. Vauglin and E. Tual (2012). Imaginaries and instruments: conceptual tools for problematizing responsible innovation. *Debating Innovation*, 2, 3: 84-90.

Campa, M.F., K. Wolfe, D. J. Bjornstad and B. L. Shumpert (2014). From Lab Bench to Fuel Pump: Researchers' Choices in the Development of Lignocellulosic Biofuels. In: C. Coenen, A. Dijkstra, C. Fautz, J. Guivant, K. Konrad, C. Milburn and H. van Lente (eds.) *Innovation and Responsibility: Engaging with New and Emerging Technologies*. Heidelberg: IOS Press/ AKA, 39-51.

Chalmers, D., R.E. McWhirter, D. Nicol, T. Whitton, M. Otlowski, M.M. Burgess, S.J.

Foote, C. Critchley and J.L. Dickinson (2014). New avenues within community engagement: addressing the ingenuity gap in our approach to health research and future provision of health care. *Journal of Responsible Innovation*, 1, 3: 321–328.

Chilvers, J. (2010). Sustainable Participation? Mapping out and Reflecting on the field of Public Dialogue on Science and Technology. Harwell: Sciencewise Expert Resource Centre.

Collingridge, D. (1980). *The Social Control of Technology*. London: Pinter.

Copeland, L. and A. Hasell (2014). Framing Effects on People's Expressed Willingness to Purchase Nanotechnology Applications in the US. In: C. Coenen, A. Dijkstra, C. Fautz, J. Guivant, K. Konrad, C. Milburn and H. van Lente (eds.) *Innovation and Responsibility: Engaging with New and Emerging Technologies*. Heidelberg: IOS Press/ AKA, 87-106.

De Bakker, E., C. de Lauwere, A-C. Hoes and V. Beekman (2014). Responsible research and innovation in miniature: Information asymmetries hindering a more inclusive 'nanofood' development. *Science and Public Policy*, 41: 294-305.

European Commission (2014). *Responsible Research and Innovation. Europe's ability to respond to societal challenges. European Union*. Available at: http://ec.europa.eu/research/swafs/pdf/pub_RI/KI0214595ENC.pdf (last accessed 14 July 2015)

Fairclough, N. (2001). *Language and Power*. Harlow: Longman.

Fairclough, N. (2003). *Analysing Discourse: Textual Analysis for Social Research*. London: Routledge.

Fairclough, N. (2010). *Critical Discourse Analysis: the Critical Study of Language*. Harlow: Pearson.

Fisher, E. and A. Rip (2013). Responsible Innovation: Multi-Level Dynamics and Soft Intervention Practices. In: R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation:*

Managing the Responsible Emergence of Science and Innovation in Society. Chichester: Wiley, 165-183.

Fonseca, P. and T.S. Pereira (2013). Emerging Responsibilities: Brazilian Nanoscientists' Conceptions of Responsible Governance and Social Technology Practices, in: K. Konrad, C. Coenen, A. Dijkstra, C. Milburn, and H. van Lente (eds.). *Shaping Emerging Technologies: Governance, Innovation, Discourse*. Berlin: IOS Press / AKA, 49-65.

Foucault, M. (1972). *The Archaeology of Knowledge*. New York: Pantheon.

Gianni, R. (2014) Framework for the Comparison of Theories of Responsible Innovation in Research, Draft Report D.5.1, 'GREAT' EC FP7 project 321480.

Gorghiu, G., G. Alina Anghela and R-M. Ion (2015). Students' perception related to a responsible research and innovation demarche. The 6th International Conference Edu World 2014 "Education Facing Contemporary World Issues", 7th - 9th November 2014. *Procedia - Social and Behavioral Sciences*, 180: 600-605.

Greenhalgh, T., G. Robert, F. MacFarlane, P. Bate, O. Kiriakidou, R. Peacock (2005). Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review. *Social Science and Medicine*, 61: 417-430.

Greenwood, R. and R. Suddaby (2006). Institutional entrepreneurship in mature fields: the big five accounting firms. *Academy of Management Journal* 49: 27-48.

Grinbaum, A. and C. Groves (2013). What is 'Responsible' about Responsible Innovation? Understanding the ethical issues. In: R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chichester: Wiley, 119-142.

Groves, C. (2015). Logic of choice or logic of care? uncertainty, technological mediation and responsible innovation. *Nanoethics*, 9: 321–333.

Grunwald, A. (2011). Responsible innovation: bringing together technology assessment, applied ethics, and STS research. *Enterprise and Work Innovation Studies*, 7: 9-31.

Guston, D. (2013). Daddy, Can I Have a Puddle Gator?": Creativity, Anticipation, and Responsible Innovation. In: R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chichester: Wiley, 109-118.

Habermas, J. (1984). *The Theory of Communicative Action: Vol 1: Reason and the Rationalization of Society* (trans. T. J. McCarthy). Boston: Beacon Press.

Hajer, M. (1993). Discourse Coalitions and the Institutionalization of Practice: The Case of Acid Rain in Britain. In: F. Fischer and J. Forrester (eds.) *The Argumentative Turn in Policy Analysis and Planning*, Durham, NC: Duke University Press, 43-76.

Hajer, M. (2003). A Frame in the Fields: Policy-making and the Reinvention of Politics. In: M. Hajer and H. Wagenaar (eds.): *Deliberative Policy Analysis: Understanding Governance in the Network Society*, Cambridge: Cambridge University Press, 88-110.

Hajer, M. and W. Versteeg (2005). A decade of discourse analysis of environmental politics: achievements, challenges, perspectives. *Journal of Environmental Policy and Planning*, 7, 3: 175–84.

Halme, M. and M. Korpela (2014). Responsible innovation toward sustainable development in small and medium-sized enterprises: a resource perspective. *Business Strategy and the Environment*, 23, 8: 547-566.

Hankins, J. and C. Grasseni (2014). Collective food purchasing networks in Italy as a case study of responsible innovation. *Glocalism: Journal of Culture, Politics and Innovation*, 1-2: 13-27.

Jasanoff, S., S-H. Kim and S. Sperling (2007). *Sociotechnical Imaginaries and Science and Technology Policy: a Cross-national Comparison*. NSF Research Report, Harvard University.

Jirotko, M. (2015). Panel discussion at 'Responsible Research and Innovation – New Frontiers'. Symposium at UCL Hub for Responsible Research and Innovation, University College London, 9 November.

Kuhlmann, S. and A. Rip (2014). The challenge of addressing Grand Challenges. Accessed May 13, 2016.

http://doc.utwente.nl/92463/1/The_challenge_of_addressing_Grand_Challenges.pdf

Li, F., R. Owen and E. Simacova (2015). Framing responsible innovation in synthetic biology: the need for a critical discourse analysis approach. *Journal of Responsible Innovation*, 2, 1: 104–108.

Lövbrand, E., R. Pielke and S. Beck (2011). A democracy paradox in studies of science and technology. *Science, Technology and Human Values*, 36: 474–496.

Macnaghten, P. and J. Chilvers (2014). The future of science governance: publics, policies, practices. *Environment and Planning C: Government and Policy*, 32: 530-548.

Macnaghten, P., S. Davies and M. Kearnes (2010). Narrative and Public Engagement.

Some findings from the Deepen Project. In: R. von Schomberg and S. Davies (eds.)

Understanding public debate on nanotechnologies. Options for Framing Public Policy.

Luxembourg: Publication Office of the European Union, 13-29.

Macnaghten, P. and R. Owen (2011). Good governance for geoengineering. *Nature*, 479: 293.
17 November.

Macnaghten, P., R. Owen, J. Stilgoe, B. Wynne, A. Azevedo, A. de Campos, J. Chilvers, R. Dagnino, G. di Giulio, E. Frow, B. Garvey, C. Groves, S. Hartley, M. Knobel, E. Kobayashi, M. Lehtonen, J. Lezaun, L. Mello, M. Monteiro, J. Pamplona da Costa, C. Rigolin, B. Rondani, M. Staykova, R. Taddei, C. Till, D. Tyfield, S. Wilford and L. Velho (2014). Responsible innovation across borders: tensions, paradoxes and possibilities. *Journal of Responsible Innovation*, 1, 2: 191-199.

Menevidis, Z., Swartzman, S. and E. Stylianidis (2011). Code of Conduct for FP7 Researchers on Medical and Biometric data Privacy. In: R. von Schomberg (ed.) European Commission. *Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields*. Luxemburg: Publication Office of the European Union, 99-114.

Mouffe, C. (2000). *The Democratic Paradox*. London: Verso.

Muniesa, F. and M. Lenglet (2013). Responsible Innovation in Finance: Directions and Implications. In: R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chichester: Wiley, 185-198.

Nordmann, A. (2007). If and then: a critique of speculative nanoethics. *Nanoethics*, 1: 31-46.

Nordmann, A. (2014). Responsible innovation, the art and craft of anticipation. *Journal of Responsible Innovation*, 1, 1: 87-98.

- Owen, R. and N. Goldberg (2010). Responsible innovation: a pilot study with the UK Engineering and Physical Sciences Research Council. *Risk Analysis*, 30, 11: 1699-1707.
- Owen, R., P. Macnaghten and J. Stilgoe (2012). Responsible research and innovation: from science in society to science for society, with society. *Science and Public Policy*, 39: 751–760.
- Owen, R. J. Stilgoe, P. Macnaghten, M. Gorman, E. Fisher and D. Guston (2013). A Framework for Responsible Innovation. In: R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*, Chichester: Wiley, 27-50.
- Pandza, K. and P. Ellwood (2013). Strategic and ethical foundations for responsible innovation. *Research Policy*, 42: 112-1125.
- Parkhill, K., N. Pidgeon, A. Corner and N. Vaughan (2013). Deliberation and Responsible innovation: a Geoengineering Case Study. In: R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chichester: Wiley, 219-239.
- Pavie, X., V. Scholten and D. Carthy (2014). *Responsible Innovation: From Concept to Practice*. Singapore: World Scientific.
- Ravesteijn, W., J. He and C. Chen (2014). Responsible innovation and stakeholder management in infrastructures: the Nansha port railway project. *Ocean & Coastal Management*, 100: 1-9.
- Reillon, V. (2016). The European Research Area. Evolving concept, implementation challenges. European Parliamentary Research Service, D-G for Parliamentary Research Services, European Parliament. 40 pp.

Reinsborough, M.T. and G. Sullivan (2011). The regulation of nano-particles under the European biocidal products directive: challenges for effective civil society participation.

European Journal of Law and Technology, 2, 3: 1-18. Available at:

<http://ejlt.org/article/view/93/158> Accessed 15 July 2015.

Rose, H. and S. Rose (1969). *Science and Society*. Penguin, Harmondsworth.

Schmidt, V. (2010). Taking ideas and discourse seriously: explaining change through discursive institutionalism as the fourth 'new institutionalism. *European Political Science Review*, 2, 1: 1-25.

Scholten, V.E. and P.A. van der Duin (2015). Responsible innovation among academic spin-offs: how responsible practices help developing absorptive capacity. *Journal on Chain and Network Science*, 15, 2: 165-179.

Scott, R. (2008). *Institutions and Organizations: Ideas and Interests*. 3rd ed. Thousand Oaks, CA: Sage.

Selin, C. (2014). On not forgetting futures. *Journal of Responsible Innovation*, 1, 1: 103-108.

Shortall, O.K., S. Raman and K. Millar (2015). Are plants the new oil? Responsible innovation, biorefining and multipurpose agriculture. *Energy Policy*, 86: 360-368.

Stahl, B. (2013). Responsible research and innovation: the role of privacy in an emerging framework. *Science and Public Policy*, 40: 708-716.

Stahl, B., N. McBride, K. Wakunuma and C. Flick (2014). The empathic care robot: a prototype of responsible research and innovation. *Technological Forecasting and Social Change*, 84: 74-85.

Stilgoe, J., R. Owen and P. Macnaghten (2013). Developing a framework for responsible innovation. *Research Policy*, 42: 1568–1580.

Sutcliffe, H. (2011). A report on Responsible Research and Innovation. MATTER, London.

Van Est, R. (2010). From techno-talk to social reflection and action. Lessons from Public Participation in Converging Technologies. International workshop on “Deliberating converging technologies”, IÖW, Berlin, 25-26 November 2010.

Van Oudheusden, M. (2014). Where are the politics in responsible innovation? European governance, technology assessments, and beyond. *Journal of Responsible Innovation*, 1:1, 67-86.

Von Schomberg, R. (2010). Organising Collective Responsibility: On Precaution, Codes of Conduct and Understanding Public Debate. In: U. Fiedeler, C. Coenen, S.R. Davies, A. Ferrari (eds.) *Understanding Nanotechnology: Philosophy, Policy and Publics*. Heidelberg: IOS Press / AKA, 61-70.

Von Schomberg, R. (2011a). Prospects for Technology Assessment in a framework of responsible research and innovation. Pre-publication version of chapter for: M. Dusseldorp and R. Beecroft (eds). *Technikfolgen abschätzen lehren: Bildungspotenziale transdisziplinärer Methoden*, Wiesbaden: Vs Verlag.

Von Schomberg, R. (2011b). Towards responsible research and innovation in the information and communication technologies and security technologies fields

Von Schomberg, R. (2012). Prospects for Technology Assessment in a framework of responsible research and innovation. In: M. Dusseldorp and R. Beecroft (eds.) *Technikfolgen abschätzen lehren: Bildungspotenziale transdisziplinärer Methoden* [Assessing Technological

Impacts: Educational Potentials of Transdisciplinary Methods], Wiesbaden: Vs Verlag, 39-61.

Von Schomberg, R. (2013). A Vision of Responsible Research and Innovation. In: R. Owen, J. Bessant and M. Heintz (eds.) *Responsible Innovation: Managing the Emergence of Science and Innovation in Society*. Chichester: Wiley, 51-74.

Von Schomberg, R. (2014). The Quest for the 'Right' Impacts of Science and Technology: A Framework for Responsible Innovation. In: J. van den Hoven, N. Doorn, T. Swierstra, B.-J. Koops and H. Romijn (eds.) *Responsible Innovation 1: Innovative Solutions for Global Issues*. Heidelberg: Springer, 33-50.

Wickson, F. and A. L. Carew (2014). Quality criteria and indicators for responsible research and innovation: learning from transdisciplinarity. *Journal of Responsible Innovation*, 1, 3: 254-273.

Wilsdon, J. (2014). From foresight to hindsight: the promise of history in responsible innovation. *Journal of Responsible Innovation*, 1, 1: 109-112.

Wodzisz, R. (2015). Case Study of R-1234yf refrigerant: implications for the framework for responsible innovation. *Science And Engineering Ethics*, 21, 6: 1413-1433.

Wynne, B. (2011). Lab work goes social, and vice-versa: strategizing public engagement processes. *Science and Engineering Ethics*, 17: 791-800.

Table 1

Publications containing ‘responsible innovation’ in title (on Web of Science)

	pre-1975	1976-1985	1986-1995	1996-2005	2006-2015
Number of results	1	1	1	2	75

Source: Web of Science search conducted on 25/3/16 (excludes duplicated results within Web of Science and non-English language outputs)

Table 2

Publications containing ‘responsible innovation’ in title (on Google Scholar)

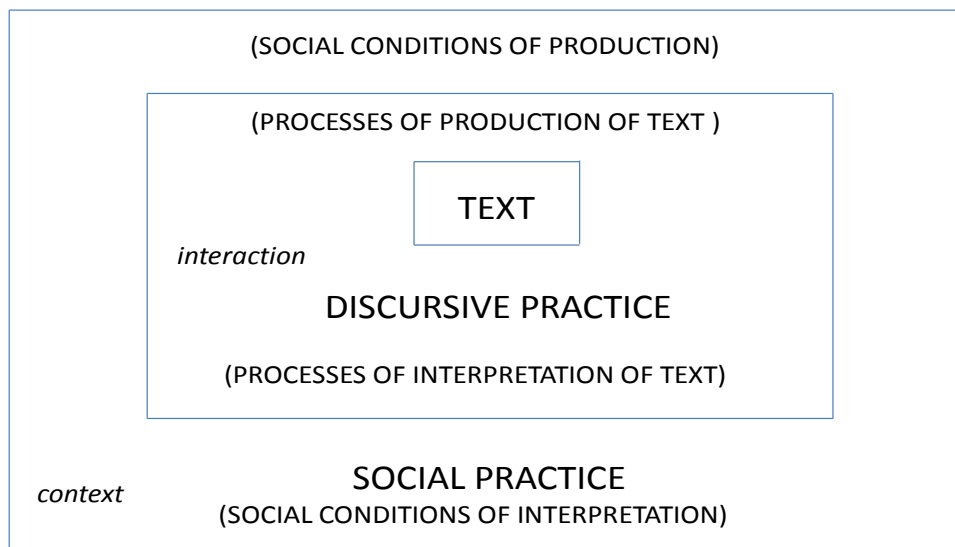
	pre-1975	1976-1985	1986-1995	1996-2005	2006-2015
Number of results	0	2	1*	2	238

* This is a misattributed reference to the book by Owen et al (2013)

Source: Google Scholar search conducted on 24/3/16 (excludes citations and patents, duplicated results within Google Scholar and non-English language outputs)

Figure 1

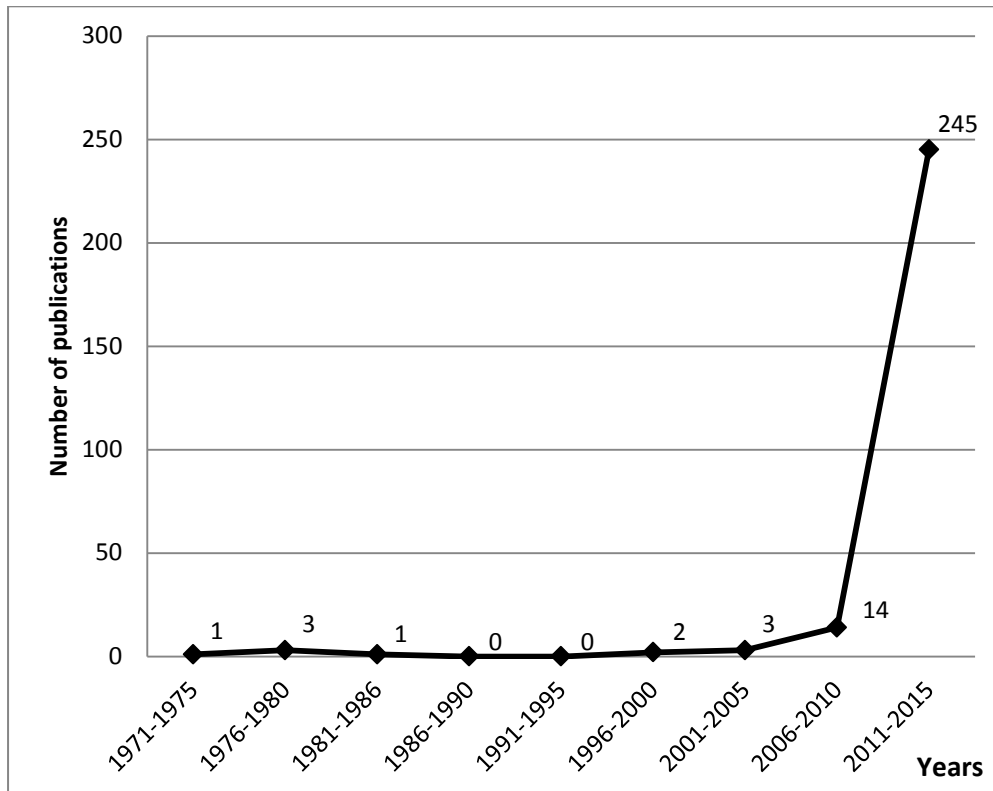
Elements of discourse



Source: adapted from Fairclough (2003)

Figure 2

Combined results from ‘responsible innovation’ in title searches on Google Scholar and Web of Science (1971-2015)

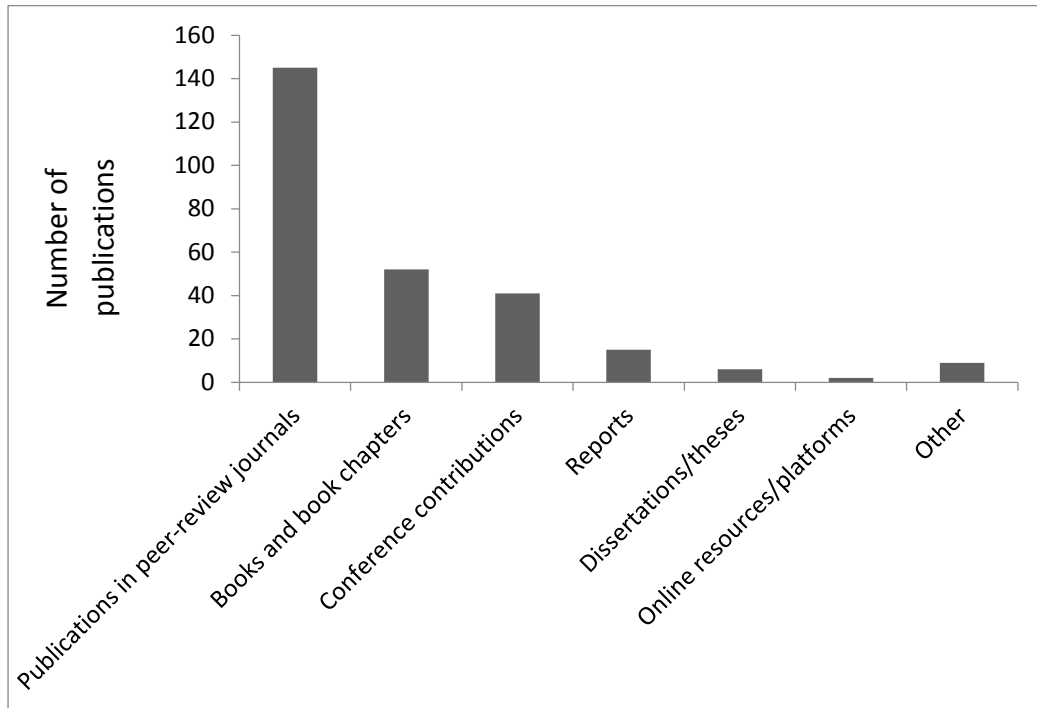


Note: duplicates and non-English language results removed

Source: Authors

Figure 3

Distribution of publications with responsible innovation in title, by category of publication



Source: Authors