# Responsible research and innovation: From science in society to science for society, with society

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The term responsible (research and) innovation has gained increasing EU policy relevance in the last two years, in particular within the European Commission's Science in Society programme, in the context of the Horizon 2020 Strategy. We provide a brief historical overview of the concept, and identify three distinct features that are emerging from associated discourses. The first is an emphasis on the democratic governance of the purposes of research and innovation and their orientation towards the 'right impacts'. The second is responsiveness, emphasising the integration and institutionalisation of established approaches of anticipation, reflection and deliberation in and around research and innovation, influencing the direction of these and associated policy. The third concerns the framing of responsibility itself in the context of research and innovation as collective activities with uncertain and unpredictable consequences. Finally, we reflect on possible motivations for responsible innovation itself.

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## 1. Introduction: the emergence of responsible innovation in EU policy discourse

The terms 'responsible innovation' and 'responsible research and innovation' have a history stretching back a decade (Hellstrom 2003; Guston 2004; Owen et al. 2009a; Owen and Goldberg 2010; von Schomberg 2011a,b; Lee 2012; Armstrong et al. 2012), and even further if cognate terms such as 'responsible development' are included (National Nanotechnology Initiative (2007) and National Research Council (2006)[1] in the USA: see Fisher and Rip (in press) for further discussion). Indeed, these terms are heirs to even earlier discussions about research integrity and the ethical, legal and social implications of research in areas such as genomics. They also have roots in visions for collaborations between social, natural and physical scientists that address the wider dimensions of science and innovation early on (evident for example within the 5th and 6th EU Framework Programmes and their calls for socio-technical integration (Rodriguez et al, in press)) and

calls for greater public engagement with science and technology (variations in which are analysed at an EU-wide level by Mejlgaard et al. (pp. 741–50, this issue)). Further roots include, but are not limited to, integrated approaches such as technology assessment in its various forms (Schot and Rip 1996; Guston and Sarewitz 2002) and anticipatory governance (Karinen and Guston 2010), some of which have been formalised within decision-making processes, such as the so-called 'Danish model' for technology assessment based on public participation and deliberation (e.g. through consensus conferences), (see Mejlgaard et al. pp. 741–50, this issue).

Over the last two years the concept of responsible research and innovation (RRI) has gained particular visibility and traction in an EU, and specifically European Commission (EC) policy context. Evolving from discourses of socio-technical integration within and beyond the EC Science in Society programme, RRI may also reflect recognition of the limitations of extant policy approaches to managing ethically-problematic areas of

science and innovation such as genetically modified organisms (Grove-White et al. 2000), synthetic biology (TNS-BRMB 2009), geoengineering (Royal Society 2009) and information and communication technology (von Schomberg 2011a), coupled with an increasing awareness of the sometimes profound, global (and intergenerational) impacts of innovations in contemporary society (Jonas 1984; Adam and Groves 2011), of which those in the financial sector are one notable recent example (Mackenzie 2010; Armstrong et al. 2012; Muniesa and Lenglet in press).[2] These have catalysed an increasing willingness at a policy level to discuss, challenge and rethink linear models of science and innovation policy and the social contract for science (in which scientific freedom is exchanged for the promise or expectation of socially-beneficial impacts) and risk-based regulation as a predominant innovation governance paradigm (Owen et al. 2009b; Owen et al. in press).

Angst over the dilemma of control for emerging technologies (Collingridge 1980; Royal Commission on Environmental Pollution 2008) (and how to proceed under conditions of uncertainty and ignorance), has also been accompanied by growing concerns about the public value of science, the need to demonstrate research 'impact' (Kearnes and Weinroth 2011) and the place of public participation in both setting research agendas and modulating research trajectories towards socially desirable ends (Fisher et al. 2006; Jones 2008). Questions of purpose, values-sensitive design (van den Hoven et al. 2012), ethics (von Schomberg 2007), social desirability, social acceptability and governance (Karinen and Guston 2010) have all coalesced around an emerging zeitgeist for 'responsible innovation' that may intuitively feel right, but which exhibits a lack of clarity in terms of definition, practice and, at a policy level, motivation.

The emergence of RRI in EU policy discourse is a recent phenomenon. It was in May 2011 that the first public statements indicated its significance within emerging EU policy, at a workshop held at the Directorate-General Research in Brussels and attended by a number of experts drawn from academia and policy (European Commission 2011). Opening the meeting, Octavi Quintana, Director of the European Research Area (ERA), stated:

> We need your help to define responsible research and innovation. After several years of research on the relation between science and society, we evidenced that we need to involve civil society very upstream to avoid misunderstanding and difficulties afterwards ... We cannot guarantee the social acceptability for anything but the more we have dialogue the easier it is to understand the potential obstacles and to work on them ... Your advice is important to help us build a policy for the years to come, notably for the Common Strategic Framework that will begin its life in 2014 and for the European Research Area.

The purpose of the event, to reflect on and develop a shared understanding of the meaning of RRI, was clear, as was its significance: to formulate policy recommendations that would support the development and implementation of a policy underpinned by the concept across the ERA. Although the motivations at an EU policy level were unclear, it was evident that responsible innovation was important to the EC, at least in sentiment, and that we were being asked to reflect and advise on what it meant, and how it might be defined (Sutcliffe 2011).

A week later, on the 23–24 May 2011, an international workshop on the theme 'Responsible Innovation' was also held at the French Embassy in London.[3] This also brought experts and policy-makers together to discuss the concept, building on emerging work in a number of countries including the UK, Holland and the USA. Building on decades of complimentary study in fields of technology assessment (Rip et al. 1995; Schott and Rip 1996; Guston and Sarewitz 2002), anticipatory governance (Karinen and Guston 2010), socio-technical integration and 'midstream modulation' (Fisher et al. 2006; Fisher 2007; Schuurbiers and Fisher 2009; McGregor and Wetmore 2009) and public and stakeholder engagement (Stirling 2005; Wilsdon et al. 2005; Sykes and Macnaghten in press) the purpose of the workshop was to come to a common understanding and definition of responsible innovation, discuss how it might differ from what has come before, and what it might involve in practice. Would this emerge as a genuinely transformative and even novel approach to governing science and innovation or would it merely be a repackaging of existing concepts to smooth the pathway for predefined policy goals?

It was at this meeting that the EC signalled more concrete intentions. First, Gilles Laroche announced on behalf of the European Commission that the EC would fund a programme of research and coordination within the remaining period of the 7th Framework Programme on RRI, to include projects aimed at developing governance frameworks; that an expert group with the same title would be established to advise the EC; that the EC would seek an Opinion from the European Group of Ethics; and that it would seek to develop a recommendation on RRI for the ERA, including a possible 'soft law' initiative (Laroche 2011). Reflecting on the fact that:

> ... the societal perception and impacts of technology are difficult (impossible) to predict.

He also stated that:

> ... early societal intervention may enable anticipation of positive and negative impacts.

The goals, to develop a European model of RRI, would need to be based on the principle of inclusiveness, involving all actors at an early stage (researchers, civil

society organisations, industry and policy-makers), allowing innovation to be developed in a co-building mode that 'ensures co-responsibility'. It would help meet the EU's 2020 Vision for an ERA firmly rooted in society and responsive to its needs and ambitions, heralding a transformation from science in society to 'science for society, with society' (Laroche 2011).

It was also at this meeting that a paper was circulated by Rene von Schomberg from the European Commission, outlining his emerging philosophical thinking (von Schomberg 2011b). This included a thoughtful discussion concerning the normative targeting of research and innovation towards the 'right impacts', anchored within the values articulated within the EU Treaty, more of which we will consider presently. It also included a proposal for a working definition:

> Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society). (von Schomberg 2011b)

There have been at least seven international workshops of varying sizes over the last 18 months on the topic of responsible innovation (Fisher and Rip in press), reflecting growing momentum in both academic and EU policy contexts. One of these was held under the auspices of the Danish presidency of the EU: a conference on Science and Society in Europe, with the subtitle, 'Responsible Research and Innovation' (Ministry of Science, Innovation and Higher Education 2012). Opening the conference, Morten Østergaard, the Danish Minister for Science and Education, re-emphasised the evolving ambition at a policy level to support 'the best science *for* the world' and not just 'the best science *in* the world'. Presenting via video-link, EU Commissioner Máire Geoghegan-Quinn provided the first tangible evidence of high-level EC policy support for the concept (Geoghegan-Quinn 2012). Framing the RRI concept as one supporting the EC's Horizon 2020 Strategy[4] for the Framework Programme (which itself implements the EU 2020 flagship 'Innovation Union' initiative aimed at securing Europe's global competitiveness) she stated:

> ...to overcome the current economic crisis we need to create a smarter, greener economy where prosperity will come from research and innovation...In the search for prosperity, jobs and a better life for everyone, research, innovation and new technologies present us with many different choices and many possible paths to follow...Researchers, policy makers, business people, innovators and most of all, the general public, have difficult choices to make as regards how science and technology can help tackle our different societal challenges...we can only find the right answers by involving as many stakeholders as possible in the research and innovation process. **Research and innovation must respond to the needs and ambitions of society, reflect its values and be responsible... our duty as policy makers (is) to shape a governance framework that encourages responsible research and innovation.** (Geoghegan-Quinn 2012, bold text as in original statement)

The more instrumental EU policy framing of RRI within the Horizon 2020 Strategy[5] was re-enforced by EC Deputy Head of Cabinet Waldemar Kutt at a panel presentation at the Euroscience Open Forum meeting, held July 2012 in Dublin, Ireland entitled 'Can Responsible Research and Innovation expedite Europe's economic renewal?' At face value, this presentation, which emphasised goals of economic growth, jobs and strengthened economic governance, may appear to frame RRI as being narrowly, and instrumentally, motivated to support the delivery of a precommitted policy, with economic growth as its main priority. Quite apart from the fact that the EC's Horizon 2020 Strategy has other important targets for innovation beyond economic growth (e.g. under its 'Better Society' theme), the language of RRI at this meeting and others before it involving the EC (often convened under the Science in Society programme) has in fact been more nuanced, and more ambiguous. This ambiguity may reflect a range of motivations in different parts, and at different levels, of the EC.

Instrumental motivations include a desire to reposition the Science in Society programme within the Horizon 2020 initiative in the face of budgetary pressures. This repositioning explicitly brings innovation within the remit of the Science in Society programme, to underpin the meeting of the Horizon 2020 strategic goals, extending the success the programme has had in facilitating the involvement of civil society with research to include innovation, and to include industry and business (where involvement has historically been limited). This, however, disguises the motivations of at least some at the EC, particularly within the Science in Society programme itself, who envisage a more normative and substantive process that builds on decades of research in science and technology studies, philosophy and beyond.

But what might this process be? RRI has, at least in sentiment, positive, constructive overtones. As the definition provided by von Schomberg suggests, science and innovation are envisaged as being directed at, and undertaken towards, socially desirable and socially acceptable ends, through an inclusive and deliberative process. This offers both opportunities for innovation as well as for flexible management and, where appropriate, control before technological 'lock-in' (Collingridge 1980). As a term, RRI seems hard to argue against—few would argue for irresponsible research and innovation. But, beyond this sentiment, what features can we distil from the emerging discourse of RRI in both academic and policy circles? What might it actually involve? And can it

ever be of practical value (and indeed implementable) given that innovation is in reality complex, messy and collective in nature: 'knowledge spaghetti' that is often intertwined across cultures and continents (Bessant in press). If what Beck (1995) described as 'organised irresponsibility' emerges as a consequence of this complex innovation ecosystem, rather than the sole actions of an individual scientist or innovator (von Schomberg 2007), then it is in such an ecosystem that RRI must be located.

Our brief overview suggests that RRI is a rapidly evolving concept, with ambiguity as to motivation, theoretical conceptualisation and translation into practice. In this regard it exhibits traits common to many innovations in their early stages in that its purposes, processes and products are still shrouded in uncertainty. But even so, we can identify some distinct features, locating these in the context of earlier concepts, some of which we have already highlighted above. We now identify three features of RRI that we suggest are emerging from the evolving discourse. One of these calls for reflection and deliberation not only on the uncertain products of science and innovation—their intended and unintended impacts, consequences and implications—but on their very purposes and motivations. Why do it, who might benefit and who might not? In this regard, it is perhaps timely that we collectively reflect on what we feel should be the purposes and motivations for RRI as an innovation itself: we end with our own conclusions in this regard.

## 2. Three emerging features of RRI

### 2.1 Science for society: Democratising the governance of intent

The first emerging feature of contemporary RRI discourse we suggest is one that is concerned with the purposes of science and innovation, and the underlying motivations and intentions for these. It seeks to go beyond what we do not want science and innovation to do—the well-known and well-documented preoccupation with characterising and managing unintended risks (the latter often through regulation)—but what we do want it to do. This is an important departure point for RRI. It asks how the targets for innovation can be identified in an ethical, inclusive, democratic and equitable manner. RRI moves beyond the 'closing down' framing of conventional ethical review and approval, limited in scope as it is to research conduct involving people, animals and genetic material. It has a primary purpose to democratically open up and realise new areas of public value for science and innovation (Wilsdon et al. 2005). It asks for inclusive deliberation concerning the direction of travel for science and innovation—from the outset—opening up opportunities for these to be directed towards socially desirable ends. This exacerbates the tension between the principle of participation and that of scientific freedom, one that is hardly new but is of particular relevance to RRI.

For innovation this tension may be less keenly felt. Indeed, the involvement of users and other stakeholders in innovation, whether this is described as market-driven or open innovation (Chesborough 2003), and the acknowledged value of this in new product development and beyond is hardly new. And in the domain of science, one can already witness experiments involving participatory agenda setting and values-sensitive design within research programmes across the EU (e.g. in the Netherlands[6] (van den Hoven et al. 2012) and the UK (Jones 2008). For example, the Alzheimer's Society in the UK has a research network of some 200 carers and people with dementia who help set research priorities, prioritise grant applications and sit on grant selection panels[7] (Wilsdon et al. 2005).

More broadly, the realisation of economic and social value has long been considered to be a responsibility of scientific institutions (Guston 2004), morphing recently into the concept of science to meet societal challenges (Lund Declaration 2009; Kearnes and Wienroth 2011). Consideration of societal and economic 'impact' has become a funding condition of even 'blue skies' research in many countries. This feature of RRI—science for society—is perhaps then a development of a more general trend towards challenge-led science and innovation, with a framing that is broader than generating commercial value. What one senses is a desire for a more institutionalised and consistently-applied approach that is inclusive and values-based (or at least values-sensitive), in which the principle of participatory agenda setting, for example through the involvement of publics and stakeholders in the formulation of grand challenges, is embedded in science and innovation policy and its delivery as part of a more generalised governance framework, at a pan-European scale.

The RRI definition proposed above, and the statements made at an EU policy level, place a premium on inclusive participation that allows the setting of research and innovation goals, defined in terms of the 'right impacts', which are themselves anchored in societal values. The obvious question then becomes, what are the 'right impacts' of research and innovation, and what values should these be anchored in? Von Schomberg (2011a,b) suggests that we cannot aspire to the abstract ideals of the Aristotelian 'good life' (contested as these are) and takes a more pragmatic view that, at least in a European context, the 'right impacts' are those enshrined in the European Constitution, such as a competitive social market economy, sustainable development and quality of life. Meeting these, he asserts, should be achieved in a way that is ethically acceptable, socially desirable, safe and sustainable (von Schomberg in press). In combination such targets for innovation clearly embed complex dilemmas and areas of contestation. Some will be in direct opposition to one another. The Horizon

2020 Strategy stresses goals that include building industrial leadership, competitive industries, boosting job creation as well as a number of high-level EU-wide 'societal challenges', to be tackled through science and innovation that include more efficient use of resources, smarter, greener transport, a safe and secure food supply and reliable, clean and efficient energy. Which should be given more emphasis?

The World Wildlife Fund (2012) for example considers the right impacts for innovation as being dematerialisation (i.e. products, services or processes that dramatically cut the use of natural resources), restorative (i.e. innovations that contribute to net positive environmental impacts and the restoration of biodiversity and the environment, open loop (where waste from products is turned back into resources) and renewable energy and low carbon. Here there is an explicit prioritisation of innovations towards those that decouple growth from environmental impacts, protect and restore ecosystems and lead to 100% renewable energy future by 2050 (World Wildlife Fund 2012). One might extend this argument further: could any process of responsible innovation that simply serves to target innovation at those 'right impacts' which support and compound an increasingly dysfunctional, and unsustainable Capitalist socio-economic world order be viewed as an irresponsible innovation in itself?

This provocative question is posed simply to illustrate the fact that negotiation of the 'right impacts' of science and innovation is inherently a political discussion, involving considerations of power, democracy and values. RRI cannot be decoupled from its political context, and will itself always embed a strongly political dimension, particularly if it concerns itself with the governance of purpose and intent. Negotiating and prioritising the constellation of 'right impacts' will have difficult ethical dimensions and include significant political and social dilemmas. This suggests a need for substantive processes of inclusive reflection and deliberative democracy, supported by mechanisms of anticipation that describe the uncertain translation of values through to visions of impact. It is the aspiration to institutionally-embed such integrated processes in such a way that deliberation and reflection can be coupled to action (i.e. responsiveness) that is a second emerging feature of RRI.

## 2.2 Science with society: Institutionalising responsiveness

As with the first feature of the emerging RRI discourse, the second may also, arguably, be considered as being evolutionary in nature. It emphasises the integration and institutionalisation of established mechanisms of reflection, anticipation, and inclusive deliberation in and around the processes of research and innovation (Owen et al. in press; Stilgoe et al. submitted).We describe these dimensions in terms of a need, first, to anticipate: describing and

analysing intended and potentially unintended impacts that might arise, be these economic, social, environmental or otherwise, supported by methodologies that include those of foresight, technology assessment and scenario development. These do not set out to predict, but serve to both open up and explore promissory narratives of expectation as well as other plausible pathways that may lead to other impacts: to prompt 'what if . . .' questions (Guston in press). Secondly, a need to reflect on underlying purposes, motivations and potential impacts, what is known (including those areas of regulation or other forms of governance that currently exist) and what is not known, associated uncertainties, risks, areas of ignorance, assumptions, questions and (ethical) dilemmas. Thirdly, there is a need to inclusively *open up* such reflection to broad, collective deliberation through processes of dialogue, engagement and debate, inviting and listening to wider perspectives from publics and diverse stakeholders.

We have brought these three dimensions together to construct a framework for responsible innovation, stressing the need for this to be an iterative, continuous and flexible process of adaptive learning. But individually these dimensions are hardly new, building on concepts of anticipatory governance, technology assessment in its various forms and public engagement. It might be argued that their integration represents a degree of novelty, but socio-technical integration also has a history in EU policy discourse (Mejlgaard et al. pp. 741–50, this issue), including the structuring and delivery of the EU Framework Programme (to varying degrees); (Rodriguez et al. in press). It is also evident in other programmes, such as the US National Nanotechnology Initiative (Fisher 2007). And integration is a key feature of concepts of real-time and constructive technology assessment (which aims to broaden technological design, development and embedding in society by including more actors, and to use insights from such actors to modulate technological dynamics).

It is the institutionalised coupling of such integrated processes of anticipation, reflection and inclusive deliberation to policy- and decision-making processes—i.e. the dimension of responsiveness—that is an important, if evolutionary, contribution that RRI makes, and one to which the EC aspires to embed more systematically across the ERA. Over the past several decades there has been a proliferation of public engagement activities concerning science and new technologies, from citizens' juries to consensus conferences. There is considerable heterogeneity in both the nature and extent of such activities across Europe (Mejlgaard et al. pp. 741–50, this issue). These processes have also too often been detached from policy-making, which has not been responsive (Macnaghten and Chilvers 2012). Social scientists and public engagement practitioners have frequently been drawn into a preoccupation with the processes of public engagement, at the expense of a questioning of its purposes (Stirling 2005; Marris and

Rose 2010; Stilgoe 2007) and how science and innovation can change as a consequence—how they might look different in response (Stilgoe et al. submitted).

Responsiveness is a dimension that is evident in recent academic experiments involving the 'midstream modulation' of scientific trajectories described by Fisher and others within the field of nanosciences. In these experiments the introduction of social scientists and humanists has catalysed reflection, modulating research trajectories in response (Fisher and Rip in press). There are numerous ways to enact the dimension of responsiveness, from Fisher's 'governance from within' to more formalised processes of innovation stage gating, originally taken from new product development, that we have recently explored in the controversial area of geoengineering. Here the application of the responsible innovation framework directly impacted on research—in this case the decision to undertake the first publicly funded field trial of a controversial solar radiation management engineering system (Macnaghten and Owen 2011), with material influence on decisions regarding the progression and direction of this field of research, at least in the UK. These experiences have also illustrated the need for any RRI approach to be instigated from the initial definition and inception of a research programme, which must then be multidisciplinary in its construction, resourcing and delivery.

## 2.3 Reframing responsibility

Scientists already have responsibilities, including those associated with concepts of research integrity which make explicit such morally unacceptable behaviours as data falsification and plagarisation. The emerging concept of RRI, however, confers new responsibilities (Douglas 2003): and not only on scientists but on universities, innovators, businesses, policy-makers and research funders. How are grand challenges to be defined? How can they be responsive in their delivery? When should such an approach be used? And at what level (for example with every project, or at a thematic programme level)? How can emerging 'reflexive capital' be communicated to national and international policy-making at a governmental level and beyond, particularly in contentious and controversial areas of science and technology? These are responsibilities that require reflection, including at the EC itself, on the constitution, funding and delivery of science and innovation programmes. Awareness of such responsibilities is developing. Responding to a public dialogue in the UK concerning synthetic biology, David Delpy (the Chief Executive of the UK Engineering and Physical Sciences Research Council) stated:

> Research Councils have a responsibility to scrutinize the potential impacts and risks of emerging technologies, and encourage the researchers we fund to do likewise…The challenge will be to define an approach that promotes creativity and

innovation in research underpinned by a commitment to its responsible development. (Delpy 2011)

Funders have a leadership role to play in establishing a framework for responsible innovation and its associated expectations, including processes of governance and oversight. But they must also lead by example. They have a role to play in catalysing the development of capacity for responsible innovation to meet such expectations, through programmes of education and training. But while those with the gift to distribute research funds clearly have a leadership role (see European Commission (2008) for a controversial example of this in the field of nanosciences), it is also clear that innovation is a collective process that requires a collective approach to responsibility (Mitcham 2003; von Schomberg 2007; Grinbaum and Groves in press), extending beyond the early stages of research and involving other actors and users who collectively translate ideas into application and value. Von Schomberg (2007) considers that collective responsibility is supported by public debate (i.e. that 'upon everyone's shoulders rests a particular moral obligation to engage in the collective debate that shapes the context for collective decision making'), technology assessment, foresight/knowledge assessment and constitutional change, dimensions which have strong synergies with the dimensions of anticipation, reflection, deliberation and responsiveness that we have highlighted above.

The framing of responsibility itself is perhaps one of the greater intellectual challenges for those wrestling with the concept of responsible innovation. Consequentialist models of responsibility which are grounded in the status of various forms of knowledge and in which the consequences of one's actions are judged in hindsight (e.g. through legal constructs of liability or reasonable foreseeability) are deeply problematic for innovation as a future-oriented, highly uncertain activity (Ginbaum and Groves in press). Traditionally, crippled by the limits of foresight, the only alternative has been to subscribe to moral luck, to take one's chances that we can be excused from moral blame in the fullness of time. Reframing responsibility in the context of innovation as a collective, uncertain and unpredictable activity is focusing attention on dimensions of responsibility such as care and responsiveness which are values- and not rules-based, allowing for discussion concerning purposes and accommodating uncertainty (Jonas 1984; Richardson 1999; Pellizzoni 2004). It is perhaps in this regard that research around the concept of RRI might make a truly novel contribution to intellectual thought.

## 3. Conclusions: The politics of responsible innovation

The EC Science in Society Stand at the European Science Open Forum conference in Dublin, July 2012 had the title

**Figure 1.** EC Science in Society Stand at the ESOF meeting, Dublin, July 2012.

'Responsible Research and Innovation: Europe's ability to respond to societal challenges' (see Fig. 1). We have described three emergent features of RRI discourse at an EU policy level, all of which are encapsulated in that title. The first is an emphasis on science for society: a focus on purposes, where research and innovation are targeted at Europe's societal challenges and the 'right impacts', underpinned by a deliberative democracy. The second, linked to the first, is an emphasis on science with society: a focus on the need for research and innovation to be responsive to society in terms of setting its direction, and in modulating its trajectory in the face of the uncertain ways in which innovation invariably unfolds as part of its naturalisation in the world. RRI calls for institutionalised responsiveness. The third is encapsulated in the explicit linking of research and innovation to responsibility, the 'responsible' in responsible innovation (Grinbaum and Groves in press). This is prompting a re-evaluation of the concept of responsibility as a social ascription in the context of innovation as a future-oriented, uncertain, complex and collective endeavour. This, in turn, is challenging scientists, innovators, business partners, research funders and policy-makers to reflect on their own roles and responsibilities, acknowledging that the irresponsibility in innovation is a manifestation of the ecosystem of innovation and requires a collective, institutionalised response, if this is indeed possible.

Any process that asks for reflection on the purposes of innovation should also reflect on the purpose of RRI as an innovation itself. In the field of public engagement, the distinction between instrumental, normative and substantive motivations (Fiorino 1989; Stirling 2005; Sykes and Macnaghten in press) has been one useful way to consider and evaluate motivations. Is RRI a process that has normative motivations (e.g. that it is the right thing to do for reasons of democracy, equity and justice), substantive motivations (e.g. that policy choices can be coproduced with publics in ways that authentically embody diverse social knowledge, values and meanings) or instrumental motivations (e.g. that it provides social intelligence to deliver precommitted policy objectives), (see Sykes and Macnaghten in press)? Policy statements from the EC suggest that RRI has underlying motivations that are not only instrumental (i.e. in supporting the delivery of policy commitments in the Horizon 2020 Strategy and Innovation Union) but also normative and substantive (von Schomberg 2011a,b; Laroche 2011). In these position papers and statements one can discern both grand ambition and shorter-term policy goals. If RRI risks becoming a new label for business-as-usual, it also risks being used instrumentally, to smooth the path of innovation in society, and/or to achieve precommitted policies. This, we argue, should be a primary point of discussion and clarification, acknowledging we are at a stage before the term itself becomes locked-in. The purposes and motivations for RRI at a policy level must be clear.

Responsible innovation evokes a collective duty of care, first to rethink what we want from innovation and then

how we can make its pathways responsive in the face of uncertainty. Acknowledging the power of innovation to shape our collective future, RRI challenges us, first and foremost, to ask what kind of future we want innovation to bring into the world. Ultimately this has to be a project that is far grander in ambition than the delivery of short-term policies. But it must also be practicable and feasible, going beyond aspiration as a mechanism for genuine and transformative change. Responsible innovation must be a process in which innovation looks different in response. There are many in academia and policy who subscribe to this grand ambition, but whether RRI lives up to this challenge remains to be seen.

## Acknowledgements

## Notes

1. This states that:

   Responsible development of nanotechnology can be characterized as the balancing of efforts to maximize the technology's positive contributions and minimize its negative consequences...It implies a commitment to develop and use technology to help meet the most pressing human and societal needs...while making every reasonable effort to anticipate and mitigate adverse implications or unintended consequences.

2. For example asset-backed securities—collateralised debt obligations.
3. See <http://www.ambafrance-uk.org/Franco-British-workshop-on,18791> accessed 12 November 2012.
4. See <http://ec.europa.eu/research/horizon2020/index_en.cfm> accessed 12 November 2012.
5. See <www.europarl.europa.eu/document/activities/cont/201206/20120620ATT47284/20120620ATT47284EN.pdf> (page 5: 'introduction of new specific objective: 'Responsible research and innovation'). accessed 12 November 2012.
6. Maatschappelijk Verantwoord Innoveren (Responsible Innovation) programme run by the Netherlands Organisation for Scientific Research (NWO) <www.nwo.nl/nwohome.nsf/pages/nwoa_7e2ezg_eng> accessed 12 November 2012.
7. See <http://alzheimers.org.uk/site/scripts/document_pdf.php?documentID=1109> accessed 12 November 2012.

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