An unfinished journey? Reflections on a decade of responsible research and innovation

Richard Owen, René von Schomberg & Phil Macnaghten

Published online: 26 Jul 2021.

Submit your article to this journal ↗

Article views: 5047

View related articles ↗

View Crossmark data ↗

Citing articles: 25 View citing articles ↗

Routledge
Taylor & Francis Group

RESEARCH ARTICLE

OPEN ACCESS   Check for updates

An unfinished journey? Reflections on a decade of responsible research and innovation
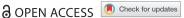
Richard Owen[a], René von Schomberg[b] and Phil Macnaghten [c]

[a]Faculty of Social Sciences, University of Bristol, Bristol, UK; [b]European Commission Brussels, Belgium; [c]Knowledge, Technology and Innovation Division, Department of Social Sciences, Wageningen University, Wageningen, The Netherlands

ABSTRACT

We reflect on a decade of Responsible Research and Innovation (RRI) as a discourse emerging from the European Commission (EC) 10 years ago. We discuss the foundations for RRI, its emergence during the Seventh Framework programme and its subsequent evolution during Horizon 2020. We discuss how an original vision for RRI became framed around five so-called 'keys': gender, open access, science communication, ethics and public engagement. We consider the prospects for RRI within the context of the EC's Open Science agenda and Horizon Europe programme, before closing with some reflections on the contribution RRI has made to debates concerning the relationship between science, innovation and society over the last decade.

Introduction

On 16 May 2011, delegates from across Europe joined staff from the EC in Brussels for a two-day workshop hosted by DG Research on 'responsible research and innovation' (RRI) (European Commission 2011). Few if any of the delegates, most of whom were academics and science policy officials, had heard of RRI. Octavi Quintana Trias, Director for the EC European Research Area, opened the workshop with these words:

> You see here a very innovative plan. We need your help to define what is responsible research and innovation. After several years of research on the relation between science and society … we would like you to reflect on the future … We would like concrete proposals on how to behave and how to approach scientific issues in order to develop policies. We need your help …

By the end of the workshop, the delegates had a response. RRI they asserted was 'a moral imperative: environmentally protective, answering social needs, demonstrating shared European values and beneficial to the widest range of actors' (de Saille 2015, 157). Ten years and many millions of Euros investment later, we reflect on a decade of RRI in Europe. What happened to this 'innovative plan'? What have we learnt? And what

---

does the future hold? In this paper, we reflect, as authors who have been close to the RRI discourse since its early beginnings, on a decade of RRI at the EC, before closing with some thoughts about its prospects for the future.

Foundations

In order to understand why RRI emerged from within the EC in 2011, we need to understand the context from which RRI emerged. Integration of social and ethical considerations into EC-funded scientific research was not new, predating RRI by several decades and extending at least as far back as the Second Framework Programme (FP2, 1987–1991) (Rodríguez, Fisher, and Schuurbiers 2013). However, the backstory for RRI really begins during the Fifth Framework Programme (FP5, 1998–2002) with the EC's publication in 2001 of its White Paper on governance, which signalled an ambition to better connect democratic institutions with European citizens (European Commission 2001).

At the time, the legitimacy of European democratic institutions was seen as being under threat. Citizens were increasingly distrustful of institutions, expertise and politics, or simply not interested in them at all. This included the institution of science. Reeling from scientific crises that included BSE, foot and mouth disease, dioxins in poultry and GM, this was an issue the EC felt it had to address. The precautionary principle, which had been enshrined in EU law since 1992, was extended in 2001 beyond environmental policy to all other policy areas of the EU, including food. Scientific advisory bodies were reconfigured and reformed. The EC called for more socially robust science, with greater involvement of citizens and organisations in shaping and delivering EU policy. There was a desire for more openness, accountability, collective responsibility and a new kind of 'scientific citizen' (Irwin 2001).

There was an instrumental motivation behind this: science and technology development were seen as being central to the knowledge economy and European competitiveness, and in this regard securing societal acceptance of new technologies and trust in science were deemed essential. But there were also substantive and normative motivations. This was an opportunity to integrate early, critical reflection on emerging areas of technoscience; i was also the right thing to do, for reasons of democracy (Rodríguez, Fisher, and Schuurbiers 2013). As part of the Sixth Framework Programme (FP6, 2002–2006), a new Programme was initiated called 'Science and Society', which aimed to bring research closer to society, to encourage greater dialogue between science and society, to address gender gaps for women in science and to promote 'responsible research and application of science and technology'. In 2009 the Lisbon Treaty enshrined in law that EU policy makers and legislators 'maintain an open, transparent, and regular dialogue with representative associations and civil society' (European Union 2007, art. 8b.2). The turn to more open, inclusive and accountable forms of scientific governance had begun. The scene was being set for RRI.

A key location for this emerging narrative in the first decade of the new millennium would be nanoscience and nanotechnologies (Rip 2014; Shelley-Egan, Bowman, and Robinson 2018). Other locations would go on to include such domains as synthetic biology and ICT. Nanosciences was one of the major thematic areas for FP6 and FP7. As an emerging techno-scientific field it had seemingly great economic and social

potential and equally great uncertainties (RS-RAE 2004). There was a desire to learn lessons from the acute political controversy that had surrounded genetically modified foods and crops, a time during which societal actors had not been sufficiently included in the research and innovation agendas of industry and governments, and lay concerns had been insufficiently recognised or addressed (Kearnes et al. 2006). There was an ambition to address criticisms of the so-called ELSI/ELSA assessment-focussed approaches of the previous decade (Jasanoff 2005, 177–178). There were ambitions to reconfigure largely unidirectional, deficit models of public engagement, which had historically been framed around a 'public understanding of science' agenda (Sykes and Macnaghten 2013). There was a desire to democratise research through 'upstream' forms of deliberative public engagement (Wilsdon and Willis 2004), to broaden the role of the social sciences in technological governance (Macnaghten, Kearnes, and Wynne 2005) and to reconfigure and enlarge the role responsibilities of scientists (Douglas 2003). There was also acknowledgement of the importance of values (such as privacy) in technological design and innovation (van den Hoven 2013). Indeed, issues of privacy, autonomy and data protection, in the context of emerging technologies such as biometrics, ICT and security technologies, led to the first volume on responsible innovation being published in 2011 (von Schomberg 2011).

Unprecedented international coordination and investment in governance, risk-related research and stakeholder and public dialogue relating to nanoscience followed (European Commission 2005). This included a 2005 EC call for proposals aimed at deepening understanding of ethical issues and embedding deliberative approaches within research on emerging technologies. An example of one of the projects funded was the DEEPEN project,[1] which undertook inter- and trans-disciplinary research aimed at identifying and characterising ethical issues relating to nano-technologies. It combined philosophical analysis with reflexive, deliberative engagement involving publics, stakeholders and the nanoscience community (Davies, Macnaghten, and Kearnes 2009; Nordmann and Macnaghten 2010). A 'Code of Conduct for Responsible Nanosciences and Nanotechnologies Research' also emerged from the EC, which included the contested principle that '[r]esearchers and research organisations should remain accountable for the social, environmental and human health impacts that their N&N research may impose on present and future generations' (European Commission 2009, 14).

The language of responsibility had begun to explicitly permeate the science and society policy lexicon. The EC 2005 Communication on Nanosciences talked about 'responsible development' (this was mirrored in the Royal Society/Royal Academy influential report on nanosciences published the year before (RS-RAE 2004)). It was also mirrored in the US, where a discourse around responsible development was emerging, notably within the US National Nanotechnology Initiative (Fisher and Mahajan 2006; Fisher 2019). A working paper published by von Schomberg at the EC in 2007 (von Schomberg 2007) on the ethics of knowledge policy had put 'collective co-responsibility' centre stage. The path for a discourse with responsibility at its very core was being cleared. The financial crisis of 2007–2008, a crisis in which complex financial innovations played no small part, only served to reinforce the need for more systemic and collective models of responsibility. If innovation was to play a part in society going forward it would need to be undertaken responsibly. But this did not mean just managing systemic

risks. The Lund Declaration of 2009 made it clear that it would also mean *orienting research and innovation to the challenges facing European society*, from climate change and sustainability to health, food security, transport, energy, ageing societies, security and pandemics.

Horizon 2020

On 23 April 2012, less than a year after the Brussels RRI workshop, delegates from across Europe convened in Odense, Denmark for a conference on Science and Society in Europe held under the auspices of the Danish EU presidency. The conference had the subtitle 'Responsible Research and Innovation'. Presenting via video-link, EU Research and Innovation Commissioner Máire Geoghegan-Quinn put RRI firmly on the European policy agenda (Geoghegan-Quinn 2012). Positioning RRI as a cross-cutting concept that would support a future 8th Framework programme called 'Horizon 2020', she stated:

> 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 …

A complete history of the genesis of former Research and Innovation Commissioner Máire Geoghegan-Quinn's RRI thinking is beyond the scope of this article. It was significant that her Chef de Cabinet, John Bell, came to his role from a period working in particular on research from the perspective of human health and cutting-edge life sciences, where ethical, human and ecological responsibility debates had been salient. It was also significant that those in several 'Research Family' DGs, and notably those working on IT developments, were coming to the conclusion that efforts within those DGs to date had been insufficient. The 'ELSIfication' of research was seen as being inadequate to ground research ethically for breakthroughs emerging in fields ranging from AI and robotics, to brain simulation and life sciences more generally. The idea was emerging within the core of the EC research-policy network that a more broadly configured concept of responsibility as well as a more radically open design for responsible science and innovation was needed.[2]

The period between 2011 and 2013, in the latter part of the Seventh Framework Programme, would prove significant: a lot happened in a relatively short space of time. Institutional entrepreneurship was key, notably by those who had a measure of agency and influence, such as Robert Madelin, then Director General at DG CONNECT, who supported inclusion of RRI as a cross-cutting issue in Horizon 2020. Another, Rene von Schomberg, circulated a vision for RRI in 2011, which included a now oft-cited definition:

> [RRI is] 'a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to 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 2011, 9; see also von Schomberg 2013)

Other initiatives, frameworks and policies for 'responsible innovation' (RI) and RRI began to emerge in parallel to that emerging from the EC.[3] In the UK for example, a framework for RI was published in 2013 and adopted by the Engineering and Physical

Sciences Research Council a year later as policy (Owen 2014; Stilgoe, Owen, and Macnaghten 2013). The Dutch Research Council (NWO) expanded its international programme on responsible innovation, a programme which had been running since 2008 and which focused on addressing societal challenges. In 2013, the first edited book on Responsible Innovation was published (Owen, Bessant, and Heintz 2013). Conferences and workshops on RI and RRI began to multiply. A global, Virtual Institute for Responsible Innovation was established (VIRI 2013). A new Journal of Responsible Innovation was proposed and then launched in January 2014 (Guston et al. 2014).

At the EC, as FP7 progressed, Science and Society had become Science in Society (SiS), and in the later years of the SiS programme, RRI was made an overarching frame for it. As Horizon 2020 approached, it would be renamed again to become Science with and for Society (SWafS) (Owen, Macnaghten, and Stilgoe 2012), capturing the zeitgeist and spirit of RRI. The programme began to fund RRI projects, including two research projects and two coordination and support actions. Momentum was growing.

Historically, projects in the Science and Society programme had focused on matters of science and society. But that would need to change. Horizon 2020 had an ambition to bring private, public and civil society stakeholders together to address grand challenges through research and innovation. Its focus was as much on innovation and the 'Innovation Union' as on science. The fledgling SWafS programme would need to adapt in order to secure its future, its budget and place in the new world order. Responsible science and research were not sufficient. Innovation had to be brought into the frame. Responsible Research and Innovation was a useful umbrella term.

The four RRI projects funded towards the end of FP7 took von Schomberg's definition as a point of departure. This signalled a break with previous science and society research funded through the EC, which had been dominated largely by evaluative approaches and the analysis of the ethics and risks of new technologies. The break we suggest was fourfold. First, as mentioned above, RRI should pre-occupy itself not only with the assessment of the risks or ethical aspects of new technologies but also *direct* science and innovation towards societal challenges, underpinned by shared European values. Second, in doing so it marked a change from the evaluative, ELSI/ELSA like practices that had dominated the programme to date, advocating an approach based on a principle of co-responsibility among stakeholders in terms of *defining and meeting social challenges* (i.e. a commitment to inclusiveness and mutual responsiveness). Third, active participation of innovators from the private, industrial, public and third sector realms was now important. This had been conspicuously absent in previous science and society programmes, a lacuna that had to be addressed if research was to lead to innovations that meet societal challenges. Fourth, those at DG Research had learned that whilst the narrative of responsible development (e.g. of nanotechnologies) emphasised early, 'upstream' engagement and interventions in the research process, it largely ignored the broader systems in which innovation sits. In order for research to deliver on societal challenges and address market-deficits (von Schomberg 2019), these innovation systems and the socio-economic context of innovation would need to be taken into consideration and reconfigured (the GREAT project emphasised this through its focus on 'second order reflexivity' (GREAT 2014)).

In other words, RRI challenged the technology–market dyad that has dominated innovation policy since the Second World War, a dyad within which innovation 'plays out in a

seemingly apolitical and conflict-free space between objective science and technology, on the one hand, and efficient rational markets, on the other' (Pfotenhauer and Juhl 2017, 69), and within which the state's primary role is to facilitate innovation[4] as a policy imperative. RRI sought both to re-imagine and reconfigure the norms, institutions and socio-political systems that direct and govern innovation and to establish the conditions for this re-imagination and reconfiguration (e.g. as experimented within two of the four original RRI projects, GREAT and RES-AGORA). It would need to be about transformative change to innovation, to innovation systems and to how these are governed. This constituted *a move from risk governance to innovation governance*. It was avowedly ambitious and constituted RRI as a political project (van Oudheusden 2014).

As FP7 approached its end, RRI appeared to have a substantial future role to play in the next framework programme, Horizon 2020. RRI had high-level support from Geoghegan-Quinn. And there were resources. Not only that, but, internationally, RRI as a discourse was gaining traction, spurred in no small part by EC funding in SWafS (for an overview of global RRI initiatives, see von Schomberg and Hankins 2019, 1–11). As time went on, the Research Council of Norway for example would launch its SAMANSVAR Programme on Responsible Innovation and Corporate Social Responsibility and make RRI a funded central element of its Digital Life Programme. China would introduce responsible innovation in its five-year plan on science, technology and innovation (2016–2021). A process of RRI translation and transduction was happening (Macnaghten et al. 2014; Doezema et al. 2019). RRI as an idea was travelling.

Keys

On 19 November 2014, delegates from across Europe met in Rome for an EC – sponsored conference entitled: 'Science, Innovation and Society – achieving Responsible Research and Innovation'. Under the auspices of the Italian presidency, it aimed to reflect on the future of science, innovation and society in Europe: RRI was, like the previous conference in Odense in 2012, the main theme. After three days of discussion at the conference a Declaration on RRI was produced. It was a call to action for European institutions to integrate RRI systematically into the implementation of research and innovation programmes (Rome Declaration 2014). The Declaration started:

> RRI is the on-going process of aligning research and innovation to the values, needs and expectations of society … [RRI] requires that all stakeholders including civil society are responsive to each other and take shared responsibility for the processes and outcomes of research and innovation.

and continued:

> This means working together in: science education; the definition of research agendas; the conduct of research; access to research results; and the application of new knowledge in society – in full respect of gender equality, the gender dimension in research and ethics considerations.

A footnote directed the reader to six RRI dimensions or 'keys'. These were specified as: 'engagement', 'gender', 'ethics', 'science education', 'open access' and 'governance'. Geoghegan-Quinn had also made reference to these six keys in her 2012 speech. Where had

these come from? Earlier visions and frameworks for RRI, responsible innovation and responsible development had, to varying degrees, been reasonably consistent in their framing, even if they lacked guidance in terms of the specifics of practice. In process terms, they emphasised the need for innovation, and research aimed at this, to be anticipatory, ethical, reflexive, engaged (with publics and stakeholders), open and mutually responsive in terms of their agendas and trajectories. They tended to envision and promote 'reflexive institutional transformations towards shared, forward-looking responsibility for innovation as a complex, dynamic and collective process' (Rip 2016) They were certainly about opening up, but not about open access *per se*. They had a little to say about pedagogy, but very little to say about science education. They talked about inclusion, but not about gender, important though this most certainly is. These might be useful entry points for RRI, but somehow RRI *was becoming* these six quite disparate 'keys', linked in some peculiar way to one another. Academics scratched their heads, trying to make sense of this.

In fact, the explanation for RRI becoming the 'keys' is one that is relatively straightforward: these keys reflected action lines (and topics within these) in the Science in Society (SiS) work programme that had existed prior to the emergence of RRI at the EC. Framing RRI as the keys provided a form of continuation between the SiS and SwafS work programmes, and the EC staff associated with them. RRI started to become synonymous with this 'package' of keys, then six keys became five, as 'governance' was felt to be too hard to implement in the work programme (Rip 2016). Ahead of the budget setting for Horizon 2020 the EC produced a document: Options for Strengthening Responsible Research and Innovation (EC 2013), which presented four options for RRI policy that ranged from business as usual to a legally binding initiative (the latter had been suggested by Gilles Laroche in his speech of March 2011). The option that would be adopted would be the second, 'improved business as usual' (de Saille 2015), rather than the one advocating transformative change.

The vision for RRI to reframe and reconfigure innovation and innovation systems and to drive and direct innovation in mutually responsive, inclusive and ethically – sensitive ways towards societal challenges had been a bridge too far. It had become caught in the ties that bind. In terms of research and innovation programming, RRI did become a cross-cutting issue within Horizon 2020. But while the Lund Declaration led to the inclusion of six major societal challenges within the programme, crucially Horizon 2020 did not support more meaningful efforts by researchers, innovators and wider stakeholders/publics to collectively 'drive innovation' towards these goals in ways envisioned by the early proponents of RRI (Robinson, Simone, and Mazzonetto 2020). DG RTD had instead prosaically introduced the RRI 'keys' as an attempt to mainstream RRI into Horizon 2020 and gone little further. These did have the pragmatic advantage of being implementable (and measurable). They were recognisable and intelligible to the researcher community and less abstract. They also had an emphasis on action towards the meeting of issues such as reducing gender inequality in science that were and continue to be important.

But in the process, the more ambitious vision for RRI was being lost. Some grantees accepted the funding and embraced RRI as the keys. Others tried to make the keys fit within RRI's larger vision. Others tactically ignored them within their projects. In 2015 an EC Expert Group chaired by Roger Strand published a number of indicators to

measure progress towards the keys in organisations and to demonstrate the impact of EC funding for RRI. Strand and Spaapen (2020) describe how this Expert Group attempted to integrate the keys with the broader vision for RRI. They set about defining indicators for the keys in broader terms (Strand and Spaapen 2020, 49–50), adding indicators for social justice and sustainability. But even so, and with the assistance of influential EC projects including MORRI,[5] 'SMART' performance indicators would inexorably become tethered to the five keys and further reify these as being synonymous with RRI. Evaluative practices, ethics, technology assessment and ad hoc forms of public engagement were also coming back on the agenda. This suited some in the academic community. Meanwhile, others criticised RRI as being an empty signifier, old wine in new bottles, or as being an incoherent, passing policy fad. Many did not meaningfully engage with, or simply gave up on, the more ambitious vision for RRI. But some kept to this vision, or their own versions of it. They experimented, sometimes drawing on forms of participatory action research, 'living labs' and 'future labs' for inspiration (e.g. FOTRRIS 2020). They attempted in different ways to wrestle RRI back to its bigger ambition. And in doing so they began to grow a community over a decade that would not have existed had RRI not existed itself. A community that included not just STS scholars, but those from science and engineering, practitioners beyond the academy and those beyond the Western context in which RRI had emerged. Community building and socialising through experience are perhaps some of RRI's most enduring legacies.

Open Science

The funding for RRI in Horizon 2020 was significant. A budget of EUR 462 million was earmarked for SWafS and by 2020 some 150 RRI projects would be funded (European Commission 2020a). However, behind the scenes, things had changed. Support within the leadership of RTD for advancing RRI beyond the keys had become limited. von Schomberg had left the SWaFS department responsible for RRI in 2012, and others followed quickly. The remaining staff were insufficiently equipped and supported to advance policies on RRI much beyond the keys. More importantly, in 2015, a new Commissioner for Research and Innovation arrived: Carlos Moedas. His policy priorities, incapsulated in the publication 'Open Science, Open Innovation and Open to the World', were different (European Commission 2015). Under the Dutch presidency in 2016, the Open Science agenda was adopted at the EU Council. Could Open Science, with its emphasis on opening up and its aim for science to be responsive to societal challenges save some of RRI's original ambition?

Certainly, Open Science is based on a vision for European research to be open, inclusive and interdisciplinary (European Commission 2015). It implies a change in the modus operandi of science, addressing all aspects of the research cycle (from scientific discovery to assessment and publishing): 'sharing knowledge and data as early as possible in the research process in open collaboration with all relevant knowledge actors' (von Schomberg 2019, 25, emphasis in original). This relates, according to this definition, not only to open access to 'knowledge sources', such as data or publications, but also to the openness (and responsiveness) of actors in research and innovation systems towards each other. It implies the involvement of relevant actors in knowledge co-production beyond the conventional academic realm, including various forms of 'citizen science' and lay

collaboration with scientists. It is also constitutive, in as much as words appear to be shaping actions and practices. It has for example begun to consider, and even at times to implement, reforms to the rewards and incentives regimes for research and innovation in research conducting organisations, for example through the work of the Open Science Policy Platform (European Commission 2020b; VSNU et al 2019). These are regimes that reify extant norms and practices in places such as universities but which RRI has largely failed to address thus far (Owen et al. 2021; Owen, Forsberg, and Shelley-Egan 2019). It seems to encourage the rewarding not only of the quantity and quality of research publications, but different *research behaviours and practices* towards more open and collaborative forms of knowledge co-production.

But can we straightforwardly expect Open Science to be the next phase for RRI? While both seek to open up research and innovation systems, they may have rather different motivations, goals and envisaged means of reaching these (Shelley-Egan, Gjefsen, and Nydal 2020). Open science can be seen firstly as a means of improving scientific efficiency and reliability, and secondly, as a means to foster data sharing and collaboration across disciplines and knowledge actors, harnessing the power of digitalisation in order to catalyse research aimed at addressing societal challenges (see Burgelman et al. 2019, for a recent overview). Certainly, Moedas' Open Science ambitions aim to include citizens from the outset (European Commission 2015). But questions remain concerning how the inclusion of citizens and publics in Open Science will be configured in practice. However, in fairness, these are questions that have also been levelled at RRI from the outset, and public engagement with science and technology more generally (Sykes and Macnaghten 2013; van Oudheusden 2014). Our sense overall is that by opening up research and innovation systems, Open Science has the potential to also open up discussions on the outcomes, entanglements and envisaged impacts of research and innovation processes, that is, in line with an emphasis on anticipation, deliberation and reflexivity as advocated by proponents of responsible innovation and RRI. We view in this sense Open Science as being an important step towards responsive research and innovation, which is, in turn, a necessary step towards responsible research and innovation (von Schomberg 2019).

Horizon Europe

With the advent of a Ninth Framework Programme – Horizon Europe (FP9, 2021–2027) – in 2021 (European Commission 2019), which launches in the midst of the greatest global pandemic in 100 years, what are the prospects for RRI? RRI certainly remains as an operational objective of the Strategic Programme (Article 2, Recital 26 of the regulation for Horizon Europe):

> With the aim of deepening the relationship between science and society and maximising benefits of their interactions, the Programme should actively and systematically engage and involve citizens and civil society organisations in co-designing and co-creating responsible research and innovation agendas and contents, promoting science education, making scientific knowledge publicly accessible, and facilitating participation by citizens and civil society organisations in its activities. *It should do so across the Programme and through dedicated activities in the part 'Strengthening the European Research Area*. (European Parliament 2018, emphasis in original)

The document 'Orientations towards the first Strategic Plan for Horizon Europe' also provides a mandate for RRI by 'engaging and involving citizens, civil society organisations and end-users in co-design and co-creation processes … ' (European Commission 2019, 21), although it has far less visibility within the programme compared with its predecessor. An optimistic view is that the Open Science agenda and Horizon Europe could offer a significant opportunity. They have an emphasis on meeting the Sustainable Development Goals and contain instruments that might potentially direct and drive innovation towards these goals, whilst promoting openness and collaboration with stakeholders and citizens. The introduction of 'mission-oriented' research, co-designed and created with stakeholders and citizens, might also open new pathways to collectively direct and mobilise strategic research and innovation towards societal challenges underpinned by European values (Robinson, Simone, and Mazzonetto 2020).

It is worth noting Horizon Europe is possibly the first public research funding programme globally to include open science as part of the excellence evaluation criterion for research proposals: these need to describe how they will implement open science practices, including open access to project outputs, and implementation of so-called FAIR principles aimed at responsible data management. Evaluation of project proposals will include assessment of the quality and appropriateness of open science practices that extends to the engagement of citizens, civil society and end users. This broadening of the excellence criterion in combination with significant funding for calls that explicitly ask for the inclusion of citizens in the development of research agendas and implementation of research and innovation projects is notable. Perhaps these interventions will go some way to putting early data and knowledge sharing at the operational heart of research.

It seems at the very least that the vision for a more open, responsive and ethical research and innovation paradigm remains. In this new era, we suggest this vision is needed more than ever. It is worth remembering that RRI emerged in the wake of one of the largest financial crises for many decades. We are now living through a similar crisis, but one of arguably even greater magnitude. Crises create legitimacy challenges for incumbent logics and the way things are done, in turn opening up space for entrepreneurship and disruptive innovation that will shape and configure our futures in ways that are likely to be profound (Owen 2020). The need for anticipation, ethical reflection and deliberation on these emerging 'futures-in-the-making' is critical. Not only that, but this is a rare moment of discontinuity when we can *change the frame for innovation*. Are we brave enough to grasp this moment?

#notgoingback?

Over the last decade, RRI has inevitably been shaped by those actors and the contexts within which it has found itself. It has, like all ideas, travelled, translated and transduced (Doezema et al. 2019). It has also become institutionalised, to varying degrees. Institutionalisation of RRI as the keys has been reported as being patchy across the European Research Area (Novitzky et al. 2020). Owen et al. (2021) similarly report patchy and uneven institutionalisation of responsible innovation (framed around the Stilgoe, Owen, and Macnaghten 2013 dimensions) in the UK. Owen et al. (2021) draw attention to the challenges of institutionalisation and transformative change, notably in the context of multiple incumbent logics that configure and incentivise certain behaviours and frame

what it means to 'be responsible' when undertaking research or innovation in places like universities. These in part relate to the configuration of interdisciplinary projects to date. While RRI has offered an opportunity for knowledge co-production across disciplines, in a number of cases it has been an accompaniment to the core technical work of research consortia (e.g. as parallel or loosely connected elements), which has done only little to foster lasting institutional change.

By way of example, a range of initiatives have been mobilised to create deeper RRI (and social sciences and humanities) knowledge creation and sharing within technical research projects within the ICT domain. Modest funding for example was made available for the 'Supporting and promoting responsible research and innovation in ICT'[6] and Hub IT[7] projects. There have also been deeper dives into specific fields such a 'Responsible ethical learning in robotics[8] and 'User Engagement for large scale pilots in the Internet of Things.[9] But at best, such specific projects were in effect so-called sister projects to the mainstream ICT research programme. Their specific contribution was to accompany the work of 'core' research consortia, to offer them a wider multi-disciplinary framework, and to crystallise RRI learnings from the exercise as a distinct object of enquiry. Such endeavours have not created a self-sustaining culture of RRI.[10]

That said, these reflect increasing examples of meaningful experimentation with RRI in recent years (e.g. Pansera et al. 2020), accompanied by significant capacity building, community building and internationalisation. These have occurred across the science and society domain over the last 10 years as a result of direct investment in RRI and in particular the investment within the SwafS programme, noting that this programme has been one of the most internationally inclusive parts of Horizon 2020 (European Commission 2020a).

Notwithstanding these successes, we argue the need to resist attempts to reify RRI as a set of disparate keys, including the institutional impulses (well-intentioned though these may be) driving such attempts in the guise of making RRI pragmatic, actionable and measurable. In part, we have argued instead the need to return to and regain some of the substance of the original visions made by RRI's early protagonists, of which we as authors are three. But can we really go back? Ideas change. The world has also changed since the original vision for RRI was developed over a decade ago and the first meeting of those delegates in 2011 in Brussels. RRI's agenda to empower society to 'care for the future through collective stewardship of science and innovation in the present' (Stilgoe, Owen, and Macnaghten 2013, 1570) is now located in a post-truth world, one where there have been profound changes over the last decade in global geopolitics, connectivity, epistemic communities and, recently, a global pandemic.

Yet, debates concerning the governance of science, technologies and innovation that have sat at the centre of RRI remain. The need for a location for those debates continues. Not only that, but over the last 10 years we have learned much at the intersection of research, innovation, responsibility and society as a result of the collaborations, projects and initiatives begun under RRI. We know much more about designing and implementing co-creation processes (Robinson, Simone, and Mazzonetto 2020), as well as the challenges of institutionalisation, particularly for RRI as a programme of transformative change. In order to foster the latter, we need to better understand, address and change those norms, logics and institutions which compete and resist RRI as a process of

transformative change (Wittrock et al. 2020). These were issues addressed by the very first RRI projects funded by the EC (GREAT and ResAGORA) and some since (e.g. JERRI[11]).

Looking forward we suggest what is important is to re-energise the challenge to the dominant technology–market dyad that has framed innovation policies since the Second World War (Pfotenhauer and Juhl 2017), one which unreflexively assumes innovation as being inherently good, desirable and the engine of choice to foster economic growth, productivity and prosperity. The deficits of this approach have been discussed elsewhere (Pfotenhauer and Juhl 2017; von Schomberg 2019). And yet we have also seen, through for example the Herculean efforts made to develop a vaccine for COVID-19, that innovation can be of critical importance to the health and future of our species. As always, it is a question of what kind of innovation, for what ends and for whom (the politics of vaccination are beyond the scope of this article but are illustrative of this point). In this regard, we stress a kind of innovation that privileges collaboration, empathy, humility and care (for others, our planet and for the future), normatively underpinned by goals such as the SDGs, as opposed to one that stresses competition, individualism and carelessness. Perhaps the world, shaken by the ravages of a global pandemic, will finally tire of the latter and embrace the former. Perhaps there will be a space for RRI if and when that choice is made.

So, what role does RRI have in the meantime? First, we suggest, RRI should continue to be an important *site for ongoing debate*, contestation and negotiation about science, technology, innovation, society and responsibility. Here it has an important role to play as a discursive space for complex, difficult discussions about the relations between science, innovation and society, the normative ends of innovation and its governance that go back many years and which will continue for many years to come (Schot and Steinmueller 2018). This, in turn, challenges us to ask whether the aim of RRI should always be consensus and agreement (across stakeholders on the goals of, values within and views surrounding innovation) or whether RRI also should be a place for encouraging dissensus, agonistic deliberation and contestation, where early and exploratory lay articulations of issues can enter into critical dialogue with dominant policy and institutional representations as a forum for mobilising political change (Macnaghten 2020).

Second, RRI should also continue to be a *site of praxis*, a location for researchers and innovators to reflect on, make sense of, enlarge and practice their responsibilities to society (Douglas 2003). Some of this echoes classical and ancient Greek virtues – including those of phroenis (Bardone and Lind 2016; Owen and Pansera 2019) and metis (Macnaghten 2016) – which may provide a grounding and contextualization for the specific normativities and values that underpin the original vision for RRI. Finally, RRI has an important role to play as a *site for politics* (Hartley, Pearce, and Taylor 2017; van Oudheusden 2014), and as a place for questions concerning the role (and efficacy) of more direct, deliberative forms of engagement with science, technology and innovation (and policies related to these) as compared with more indirect forms of representation. This in turn raises interesting questions concerning the role of the RRI practitioner and 'scholar–activist' in these schemas.

Where does that leave us? We suggest that, 10 years on, much of the initial substance and ambition of RRI remains important and necessary. From our vantage point and lived experience we can see RRI as being part of a broader conversation that has a past, present

and future, as a moment on a journey that is far from over. RRI has been an important location over the last decade, one of the most volatile in recent history, for helping 'society to get better at the conversation between today and tomorrow' (Macnaghten 2016). It has played its part in helping us to understand, reflect on and open up those futures being created by science, technology and innovation, and how we can take responsibility for those futures as a society. Our hope is that this conversation will continue.

Notes

1. The Deepen Project was one of a number of EC projects to adopt a deliberative approach. It was featured among the other projects in the publication: Understanding Public Debate on Nanotechnologies. Options for Public Policy, edited by Rene von Schomberg and Sarah Davies, Publication office of the European Union, 2010. These echoed earlier calls for deliberative approaches (e.g. von Schomberg (ed), Democratising Technology: Towards theory and practice of deliberative technology policy, 1999).
2. We are grateful to Robert Madelin for providing text in this paragraph.
3. For a fuller description of the similarities and differences between RRI and RI see Owen and Pansera (2019). We note here that the RI discourse in the UK emerged in parallel with, and not as a direct consequence of, the emergence of the RRI discourse at the EC, although of course both were linked.
4. There are others of course other roles of the state, such as the development of regulation.
5. http://morri-project.eu/ (see Deliverable 3.2, Table 3.2)
6. https://cordis.europa.eu/project/id/644200
7. https://www.hubit-project.eu/
8. www.responsiblerobotics.eu
9. www.U4IOT.eu
10. We are grateful to Robert Madelin for text in this paragraph.
11. https://www.jerri-project.eu/jerri/index.php.

Acknowledgements

Disclosure statement

No potential conflict of interest was reported by the author(s).

Disclaimer

The views expressed here are those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

Notes on contributors

Richard Owen is a Professor of Innovation Management in the School of Management, Faculty of Social Sciences, University of Bristol. He is interested in the power of innovation and techno-visionary science to create futures in profound and uncertain ways, how we can engage as a society with those futures and how we can take responsibility for them. He is interested in the

politics, risks, ethics and governance of innovation and new technologies in society. His research sits at the intersection of innovation governance and science and technology studies as a critical, interdisciplinary scholar.

Dr Dr Phil René von Schomberg is a philosopher and a STS specialist. He graduated as an agricultural scientist. He is currently a Guest Professor at the Technical University of Darmstadt. He has been a European Union Fellow at George Mason University, the USA in 2007 and has been with the European Commission since 1998. He is the author/editor of 15 books and his publications appeared in a half dozen languages. He is co-editor of the most comprehensive book on responsible innovation to date: *The International Handbook on Responsible Innovation. A global resource*. He runs a blog: https://renevonschomberg.wordpress.com

Phil Macnaghten is a Professor in the Knowledge, Technology and Innovation (KTI) group at Wageningen University. His PhD is from Exeter and he has held appointments at Lancaster, Durham and Campinas before joining Wageningen in 2015. His research background is in science and technology studies (STS) and sociology. He has worked in the science and society field on a series of science and technology controversies, developing anticipative qualitative methodologies which, in turn, have informed policy approaches to dialogue and public engagement. His current research focuses on responsible innovation, gene editing and the politics of anticipation.

ORCID

Phil Macnaghten (iD) http://orcid.org/0000-0002-6611-4583

References

Bardone, E., and M. Lind. 2016. "Towards a Phronetic Space for Responsible Research (and Innovation)." *Life Sciences, Society and Policy* 12: 5. https://lsspjournal.biomedcentral.com/articles/10.1186/s40504-016-0040-8

Burgelman, J.-C., C. Pascu, K. Szkuta, R. von Schomberg, A. Karalopoulos, K. Repanas, and M. Schouppe. 2019. "Open Science, Open Data, and Open Scholarship: European Policies to Make Science fit for the Twenty-first Century." *Frontiers in Big Data* 2: 43.

Davies, S., P. Macnaghten, and M. Kearnes. 2009. *Reconfiguring Responsibility: Deepening Debate on Nanotechnology*. Durham: Durham University. http://dro.dur.ac.uk/6399/1/6399.pdf?DDD14+dgg1mbk.

de Saille, S. 2015. "Innovating Innovation Policy: The Emergence of 'Responsible Research and Innovation'." *Journal of Responsible Innovation* 2 (2): 152–168.

Doezema, T., D. Ludwig, P. Macnaghten, C. Shelley-Egen, and E.-M. Forsberg. 2019. "Translation, Transduction, and Transformation: Expanding Practices of Responsibility Across Borders." *Journal of Responsible Innovation* 6 (3): 323–331.

Douglas, H. 2003. "The Moral Responsibilities of Scientists (Tensions Between Autonomy and Responsibility)." *American Philosophical Quarterly* 40 (1): 59–68.

European Commission. 2001. *European Governance: A White Paper*. Brussels: Commission of the European Communities.

European Commission. 2005. *Nanosciences and Nanotechnologies: An Action Plan for Europe 2005-2009*. Brussels: Directorate-General for Research and Innovation. https://ec.europa.eu/research/industrial_technologies/pdf/policy/action_plan_brochure_en.pdf.

European Commission. 2009. *A Code of Conduct for Responsible Nanosciences and Nanotechnologies Research*. Brussels: Directorate-General for Research and Innovation. https://ec.europa.eu/research/science-society/document_library/pdf_06/nanocode-apr09_en.pdf.

European Commission. 2011. *DG Research Workshop on Responsible Research & Innovation in Europe*. Brussels: Directorate-General for Research and Innovation. http://ec.europa.eu/

research/science-society/document_library/pdf_06/responsible-research-andinnovation-workshop-newsletter_en.pdf.

European Commission. 2013. *Options for Strengthening Responsible Research and Innovation*. https://ec.europa.eu/research/science-society/document_library/pdf_06/options-for-strengthening_en.pdf.

European Commission. 2015. *Indicators for Promoting and Monitoring Responsible Research and Innovation. Report from the Expert Group on Policy Indicators for Responsible Research and Innovation*. Brussels: Directorate-General for Research and Innovation. http://ec.europa.eu/research/swafs/pdf/pub_rri/rri_indicators_final_version.pdf.

European Commission. 2019. *Orientations Towards the First Strategic Plan Implementing the Research and Innovation Framework Programme Horizon Europe*. https://ec.europa.eu/research/pdf/horizon-europe/ec_rtd_orientations-towards-the-strategic-planning.pdf.

European Commission. 2020a. *Science with and for Society in Horizon 2020: Achievements and Recommendations for Horizon Europe*. Brussels: Directorate-General for Research and Innovation. https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/770d9270-cbc7-11ea-adf7-01aa75ed71a1.

European Commission. 2020b. *Progress on Open Science: Towards a Shared Research Knowledge System. Final Report of the Open Science Policy Platform*. Brussels: Directorate-General for Research and Innovation. https://ec.europa.eu/research/openscience/pdf/ec_rtd_ospp-final-report.pdf#view=fit&pagemode=none.

European Parliament. 2018. *Establishing Horizon Europe – Laying Down its Rules for Participation and Dissemination, (COM(2018)0435 – C8-0252/2018–2018/0224(COD))*. https://www.europarl.europa.eu/doceo/document/TA-8-2018-0509_EN.html.

European Union. 2007. *Treaty of Lisbon Amending the Treaty on European Union and the Treaty Establishing the European Community, 13 December 2007, 2007/C 306/01*. Brussels: Commission of the European Communities. https://www.refworld.org/docid/476258d32.html.

Fisher, E., and R. L. Mahajan. 2006. "Contradictory Intent? US Federal Legislation on Integrating Societal Concerns into Nanotechnology Research and Development." *Science and Public Policy* 33 (1): 5–16.

Fisher, E. 2019. "Governing with Ambivalence: The Tentative Origins of Socio-Technical Integration." *Research Policy* 48 (5): 1138–1149.

FOTRRIS. 2020. *Fostering a Transition Towards Responsible Research and Innovation Systems*. http://fotrris-h2020.eu/.

Geoghegan-Quinn, M. 2012. *Commissioner Geoghegan-Quinn Keynote Speech at the "Science in Dialogue" Conference*, Odense, April 23–25. https://ec.europa.eu/archives/commission_2010-2014/geoghegan-quinn/headlines/speeches/2012/documents/20120423-dialogue-conference-speech_en.pdf.

GREAT. 2014. Analytical Grid Report to EC. www.great-project.eu/deliverables_files/deliverables02.

Guston, D., E. Fisher, A. Grunwald, R. Owen, T. Swiestra, and S. van der Burg. 2014. "Responsible Innovation: Motivations for a New Journal." *Journal of Responsible Innovation* 1 (1): 1–8.

Hartley, S., W. Pearce, and A. Taylor. 2017. "Against the Tide of Depoliticisation: The Politics of Research Governance." *Policy & Politics* 45 (3): 361–377.

Irwin, A. 2001. "Constructing the Scientific Citizen: Science and Democracy in the Biosciences." *Public Understanding of Science* 10 (1): 1–18.

Jasanoff, S. 2005. *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton, NJ: Princeton University Press.

Kearnes, M., R. Grove-White, P. Macnaghten, J. Wilsdon, and B. Wynne. 2006. "From Bio to Nano: Learning Lessons from the UK Agricultural Biotechnology Controversy." *Science as Culture* 15 (4): 291–307.

Macnaghten, P. 2016. *The Metis of Responsible Innovation: Helping Society to Get Better at the Conversation Between Today and Tomorrow. Inaugural Lecture*. Netherlands: Wageningen University, Wageningen. https://wurtv.wur.nl/P2G/Player/Player.aspx?id=dIIa2u.

Macnaghten, P. 2020. *The Making of Responsible Innovation*. Cambridge: Cambridge University Press.

Macnaghten, P., M. Kearnes, and B. Wynne. 2005. "Nanotechnology, Governance, and Public Deliberation: What Role for the Social Sciences?" *Science Communication* 27 (2): 268–291.

Macnaghten, P., R. Owen, J. Stilgoe, B. Wynne, *et al.* 2014. "Responsible Innovation Across Borders: Tensions, Paradoxes and Possibilities." *Journal of Responsible Innovation* 1 (2): 191–199.

Nordmann, A., and P. M. Macnaghten. 2010. "Engaging Narratives and the Limits of Lay Ethics: Introduction." *NanoEthics* 4 (2): 133–140.

Novitzky, P., M. J. Bernstein, V. Blok, R. Braun, T. T. Chan, W. Lamers, A. Loeber, I. Meijer, R. Linder, and E. Griessler. 2020. "Improve Alignment of Research Policy and Societal Values." *Science* 369 (6499): 39–41.

Owen, R. 2014. "The UK Engineering and Physical Sciences Research Council's Commitment to a Framework for Responsible Innovation." *Journal of Responsible Innovation* 1 (1): 113–117.

Owen, R. 2020. "Innovation and Responsibility." In *Life After Covid-19: The Other Side of Crisis*, edited by M. Parker, 155–164. Bristol: Bristol University Press.

Owen, R., J. Bessant, and M. Heintz. 2013. *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. London: John Wiley.

Owen, R., A.-M. Forsberg, and C. Shelley-Egan. 2019. *RRI-Practice Policy Recommendations and Roadmaps, D.16.2.* https://www.rri-practice.eu/knowledge-repository/practical-handbook/.

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 (6): 751–760.

Owen, R., and M. Pansera. 2019. "Responsible Innovation and Responsible Research and Innovation." In *Handbook on Science and Public Policy*, edited by S. Kuhlmann, J. Stamm, and W. Canzler, 26–48. Cheltenham: Edward Elgar Publishing.

Owen, R., M. Pansera, P. Macnaghten, and S. Randles. 2021. "Organisational Institutionalisation of Responsible Innovation." *Research Policy* 50 (1): 104132.

Pansera, M., R. Owen, D. Meacham, and V. Kuh. 2020. "Embedding Responsible Innovation Within Synthetic Biology Research and Innovation: Insights from a UK Multi-disciplinary Research Centre." *Journal of Responsible Innovation* 7 (3): 384–409.

Pfotenhauer, S., and J. Juhl. 2017. "Innovation and the Political State: Beyond the Myth of Technoligies and Markets." In *Critical Studies of Innovation*, edited by B. Godin and D. Vinck, 68–94. Cheltenham: Edward Elgar.

Rip, A. 2014. "The Past and Future of RRI." *Life Sciences and Public Policy* 10 (17): 2014.

Rip, A. 2016. "The Clothes of the Emperor. An Essay on RRI in and Around Brussels." *Journal of Responsible Innovation* 3 (3): 290–304.

Robinson, D., A. Simone, and M. Mazzonetto. 2020. "RRI Legacies: Co-creation for Responsible, Equitable and Fair Innovation in Horizon Europe." *Journal of Responsible Innovation*.

Rodríguez, H., E. Fisher, and D. Schuurbiers. 2013. "Integrating Science and Society in European Framework Programmes: Trends in Project-level Solicitations." *Research Policy* 42 (5): 1126–1137.

Rome Declaration. 2014. *Rome Declaration on Responsible Research and Innovation in Europe.* https://ec.europa.eu/research/swafs/pdf/rome_declaration_RRI_final_21_November.pdf.

Royal Society & The Royal Academy of Engineering. 2004. *Nanoscience and Nanotechnologies: Opportunities and Uncertainties*. London: Royal Society.

Schot, J., and E. Steinmueller. 2018. "Three Frames for Innovation Policy: R&D, Systems of Innovation and Transformative Change." *Research Policy* 47 (9): 1554–1567.

Shelley-Egan, C., D. Bowman, and D. Robinson. 2018. "Devices of Responsibility: Over a Decade of Responsible Research and Innovation Initiatives for Nanotechnologies." *Science and Engineering Ethics* 24: 1719–1746.

Shelley-Egan, C., M. Gjefsen, and R. Nydal. 2020. "Consolidating RRI and Open Science: Understanding the Potential for Transformative Change." *Life Sciences, Society and Policy* 16: 7. https://lsspjournal.biomedcentral.com/articles/10.1186/s40504-020-00103-5#citeas

Stilgoe, J., R. Owen, and P. Macnaghten. 2013. "Developing a Framework for Responsible Innovation." *Research Policy* 42 (3): 1568–1580.

Strand, R., and J. Spaapen. 2020. "Locomotive Breath? Post Festum Reflections on the EC Expert Group on Policy Indicators for Responsible Research and Innovation." In *Assessment of Responsible Innovation*, edited by E. Yaghmaei and I. van den Poel, 42–59. London: Routledge.

Sykes, K., and P. Macnaghten. 2013. "Opening up Dialogue and Debate." In *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*, edited by R. Owen, J. Bessant, and M. Heitz, 85–107. Chichester: John Wiley.

van den Hoven, J. 2013. "Value Sensitive Design and Responsible Innovation." In *Responsible Innovation. Managing the Responsible Emergence of Science and Innovation in Society*, edited by R. Owen, M. Heintz, and J. Bessant, 75–84. London: John Wiley.

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.

VIRI. 2013. https://www.virinetwork.org/.

von Schomberg, R. 2007. *From the Ethics of Technology Towards an Ethics of Knowledge Policy and Knowledge Assessment. EUR 22429*. Brussels: European Commission Services. https://op.europa.eu/en/publication-detail/-/publication/aa44eb61-5be2-43d6-b528-07688fb5bd5a.

von Schomberg, R. 2011. *Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields. A Report from the European Commission Services*. Luxembourg: Publication Office of the European Union. https://renevonschomberg.wordpress.com/ict-and-security-technologies/.

von Schomberg, R. 2013. "A Vision of Responsible Research and Innovation." In *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*, edited by R. Owen, J. Bessant, and M. Heintz, 51–74. London: Wiley.

von Schomberg, R. 2019. "Why Responsible Innovation." In *International Handbook on Responsible Innovation: A Global Resource*, edited by R. Von Schomberg and J. Hankins, 12–32. Cheltenham: Edward Elgar.

von Schomberg, R., and J. Hankins. 2019. *International Handbook on Responsible Innovation: A Global Resource*. Cheltenham: Edward Elgar.

VSNU, NWO, NFU and ZonMw. 2019. *Statement: Recognition and Reward of Academics*. https://www.nwo.nl/en/policies/statement+recognition+and+reward+of+academics.

Wilsdon, J., and R. Willis. 2004. *See-Through-Science: Why Public Engagement Needs to Move Upstream*. London: Demos.

Wittrock, C., A. Pols, E.-M. Forsberg, P. Macnaghten, and D. Ludwig. 2020. *National and Organisational Conditions for Implementing Responsible Research and Innovation*. Dordrecht: Springer.