Responsible research and innovation: The role of privacy in an emerging framework

Bernd Carsten Stahl

Centre for Computing and Social Responsibility, De Montfort University, The Gateway, Leicester LE1 9BH, UK; Email: bstahl@dmu.ac.uk.

The concept of responsible research and innovation (RRI) is increasingly used to describe novel ways of governing research and the relationship between key research stakeholders including researchers, industry, policy-makers and civil society. It is thus of key importance for science, research and innovation policy. This paper defines RRI as a higher-level responsibility or meta-responsibility that aims to shape, maintain, develop, coordinate and align existing and novel research and innovation-related processes, actors and responsibilities with a view to ensuring desirable and acceptable research outcomes. It shows the role privacy has in the developing framework of RRI. The paper discusses dimensions of RRI as well as weaknesses of the current approach towards RRI and provides future directions for research and practice that will allow RRI to live up to its promise and ensure that past and present work on privacy and data protection find an appropriate place within this framework.

Keywords: responsible research and innovation; privacy; meta-responsibility.

1 Introduction

Responsible research and innovation (RRI) is a concept that has recently gained currency, particularly in Europe. The upcoming European research framework Horizon 2020 which is estimated to spend more than €70 billion in the period 2014–20 will be underpinned by RRI as a cross-cutting activity (Council of the European Union 2012; European Commission 2011a, 2011b; Owen et al. 2012). National frameworks and discourses on RRI are similarly springing up, for example in the UK where the Engineering and Physical Science Research Council is funding research projects into RRI,[1] or the Netherlands Organization for Scientific Research (NWO) that established a programme on responsible innovation several years ago.[2]

The present paper aims to contribute to this emerging discussion in several ways. First, it proposes a definition of RRI that is consistent with, and covers, the definitions that are most widely cited at the moment, but explicitly recognises the history of RRI-related activities that should be included in the discourse. It suggests that there are three main dimensions of RRI that need to be considered. On the basis of this definition the paper then goes on to show

the crucial role that privacy and the different ways of realising play in RRI. The paper uses this description to show potential pitfalls in the present debate and suggests ways of overcoming them.

2 RRI as a meta-responsibility

This paper defines RRI as a higher-level responsibility or meta-responsibility that aims to shape, maintain, develop, coordinate and align existing and novel research and innovation-related processes, actors and responsibilities with a view to ensuring desirable and acceptable research outcomes. The present section will briefly review the RRI discourse to show that this definition is appropriate and consistent with existing definitions and that it goes beyond the current discourse to provide additional benefits. In order to appreciate this, it is important to gain an understanding of definitions of the term that are already more broadly discussed.

2.1 History and definitions of RRI

Research has traditionally been seen as an extension of human knowledge and thus as a moral and public good.

During the 20th century the growing power of technology demonstrated the downsides of research and innovation. Two world wars, numerous technical accidents and catastrophes and mounting societal debates about contentious developments required broader societal reflection and involvement.

RRI takes its point of departure from the expected positive impacts of technology and explores what can be done to assure these. The current usage of the term first appears as 'responsible development' in the 2003 US Act: 21st Century Nanotechnology Research and Development Act (Public Law 108-153 [2]).[3] In Europe the term seems to have first been heavily promoted by the NWO which ran a series of projects and events under the heading of 'Maatschappelijk Verantwoord Innoveren'[4] from 2009. From these beginnings a broader discourse has started that currently covers academic contributions as well as policy interventions. While the idea of responsible development originally aimed mostly at addressing risks and avoiding negative outcomes, RRI has a broader remit. Instead of focusing on risks and technologies as responsible development did, RRI moves towards a broader innovation policy.

The term is gaining importance at present due to the urgency of what are often called 'grand challenges'. These include: questions of employment, economic wellbeing and growth, issues of social coherence, and the resilience of democratic societies, demographic developments, social innovations and other topics. What grand challenges have in common is that they can significantly affect the way in which modern societies work. Grand challenges are problems whose resolutions are likely to benefit from research and innovation. Addressing the grand challenges successfully would lead to the prospect of living a safe life with an increased quality of life (Hinde 2008).

Thus, societies rely on research and innovation to solve their problems, but at the same time realise that the intrinsic uncertainty of the future precludes simple predictions of the future consequences of research and innovation. This uncertainty of the future is coupled with the problem that research and innovation, as well as the challenges they try to address, are of a global nature and the traditional mechanisms of technology governance are arguably not amenable to them (Wright et al. 2011). This development is embedded in, and part of, a number of developments related to the concept of modernisation (Habermas 2007). These include the loss of religious certainty and the secularisation of Western states, increasing individualisation and pluralisation of societies and changing governance models, in particular with regards to science and technology. These are large social developments related to broader concepts such as Beck's (1986) risk society or Bauman's (2000) liquid modernity. One important aspect of these development is what Zhang et al. (2011) call the fragmentation of social authority.

The reason for the exponentially growing relevance of RRI is thus the increased importance of research and innovation and the simultaneously decreasing ability to steer it using conventional science and innovation governance measures.

In this context the concept of RRI is gaining currency. The currently most widely used definition of RRI is that it is a:

> ...transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products(in order to allow a proper embedding of scientific and technological advances in our society). (Von Schomberg 2011: 9)

This definition points to several important aspects. RRI concerns the process and product of innovation and it aims to achieve acceptable and even desirable outcomes. In order to achieve this, RRI needs to engage with the possible consequences of research and innovation through foresight and assessment processes. Part of the definition includes the public engagement of different stakeholders, a group which includes researchers and research funders as well as civil society and policymakers. The aim of RRI, to ensure positive outcomes of research and innovation, is well captured in the description of RRI as 'anticipatory governance' (Sutcliffe 2011: 7). This paper follows that idea and, in line with Owen and Goldberg (2010: 1706), sees RRI as:

> ...adaptive and anticipatory [research and innovation] governance.

What these definitions fail to emphasise to a sufficient degree is that RRI is constituted by numerous activities, actors and foundations that in most cases predate the term considerably. In order to demonstrate this, this paper now outlines the most important dimensions of RRI already discussed in the literature.

2.2 Dimensions of RRI

This paper emphasises the multiplicity of extant components of RRI that calls for the aforementioned definition. In order to discuss these, it suggests viewing RRI as a space constituted by activities, actors and norms. Fig. 1 represents two separate attempts to graphically represent this space.

This section discusses the components of the space of RRI in order to provide an understanding of current activities, which is required to appreciate the suggested definition. Furthermore, outlining the space of RRI provides the conceptual basis that allows the role of privacy to be located in this space.
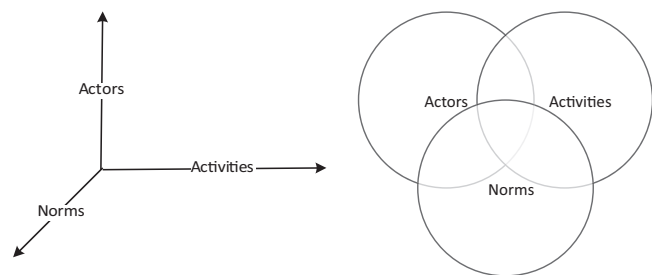
Figure 1. Different Attempts to Graphically Represent the Space of RRI.

2.2.1 Activities of RRI. The current literature points to a range of activities in this space that RRI can make use of, or needs, to develop. The present paper does not offer the space to discuss them in detail. It is nevertheless important to gain an overview of these activities for the reader to follow the argument of this paper.

There is a range of different types of assessment that make up a key component of RRI. There are numerous ways of assessing aspects of research and innovation projects. These include risk assessment, which has been used as a way of integrating RRI in research and innovation (Owen and Goldberg 2010). It offers the added advantage of being an established mechanism of governance. Furthermore, RRI can draw on impact assessment to proactively engage with the possible consequences of particular types of assessment. Risk assessment may be seen as one type of impact assessment. Technology assessment (TA), to name a final discourse on assessment, is an established stream of activities which covers impact assessments as well as other components discussed below (Grunwald 2009; Schot and Rip 1996). There are numerous different traditions and practices of TA, such as participative TA (Bellucci and Joss 2002; Decker and Ladikas 2004) or constructive TA (Genus and Coles 2005).

RRI-related assessment activities tend to focus on future occurrences. This implies that there is some way of gaining an understanding of the future. Foresight activities are therefore a key aspect of RRI. This is traditionally done by futures studies (Sardar 2010) or foresight research (Cuhls 2003; Martin 2010), which can be seen as integral to RRI. It has been pointed out that foresight activities are particularly relevant in addressing grand challenges (Cagnin et al. 2012).

One frequently cited aspect of RRI is that it moves beyond the researcher and expert-centred view of research and innovation and explicitly includes a broader set of stakeholders. This is based on the recognition that research and innovation need to be beneficial to all stakeholders, who should thus be involved in all aspects of RRI. This includes early (upstream) engagement as well as midstream and downstream activities (Fisher et al. 2006). This aspect can draw on a large array of possible activities

(Rowe and Frewer 2005). It is at this point that deliberative democracy finds its linkage to RRI (Von Schomberg 2012).

Research activities, in order to count as responsible, need to open up to external scrutiny. Some aspects of the processes related to RRI are open to external aims and thus to scrutiny by bodies independent of the actual research. This refers to activities such as ethics reviews which are normally done by external bodies as well as standards of research integrity,[5] which govern research in many areas. In addition to such external scrutiny, research needs to develop internal reflexivity. In order to understand ethical issues and explore the assumptions and consequences of research, it is desirable to integrate mechanisms of explicit reflection into projects. One possible ways of doing this is to have dedicated activities, such as work packages on ethical, social and legal issues, which one can often find in European projects.

There are research processes and methodologies which can be integrated into aspects of research that will contribute to RRI. One example would be value-sensitive design, which allows the explicit integration of ethical (and other) values into research (Manders-Huits and Van den Hoven 2009).

Activities in RRI need to include the provision of awareness and accountability structures. This can be done by focusing on individuals, for example by educating them to raise their awareness. A further avenue would be that of professionalism where RRI can draw on existing structures to provide incentives and guidelines for desirable behaviour. Traditionally, this is often done through codes, such as codes of ethics or codes of conduct. Another way of linking professional standards to individual behaviour is via oaths or pledges that require researchers to take broader concerns into consideration.

This enumeration of activities, which does not claim to be comprehensive, demonstrates that RRI can draw on a large range of processes and activities which are already established. Before moving to the role of privacy in RRI, the other two dimensions of the space of RRI are briefly outlined.

2.2.2 Actors in RRI. The above discussion of possible components of RRI has already demonstrated that RRI comprises a broad array of actors. These include individual researchers, research organisations (both publicly and privately funded), research ethics committees and their members, users of research and innovation, civil society actors policy-makers at different levels, professional bodies, legislators, educational organisations (e.g. schools and universities) and public bodies (from local authorities to regional structures).

Many of the activities above refer to a number of different actors on this list. Education, for example

requires the individual researcher's engagement, it requires a legal framework, often supported by professional bodies and is implemented by educational organisations. Thus, there is a complex relationship between actors and their activities.

Again, this list does not claim to be exhaustive but aims to give an indication of relevant actors.

2.2.3 Normative foundations of RRI. RRI needs fundamental normative principles in order to evaluate whether a particular type of research or innovation is indeed desirable or acceptable. As outlined above, one of the core problems and motivators of RRI is, however, that there is a fragmentation of moral authority. Globalisation, liberalism and the broader developments of Western societies during the 20th century have left any moral consensus that societies may have had in the past contested. Any RRI implementation likely to succeed therefore needs to reflect on the normative principles on which it is built. This paper now discusses a set of candidates which, again, does not claim to be comprehensive.

One way of determining what counts as responsible is to look at the existing norms and principles of democratic governance. There are a number of candidates of normative principles and codes that can count as the underlying principles of RRI. At the European level, a key source of established normative principles may be the European treaties (Von Schomberg 2013) and the large set of regulations and case law that are based on them. The most widely established set of principles are probably human rights, which includes those promoted by the UN as well as the similar European ones as promoted by the European Convention on Human Rights and the European Charter of Fundamental Rights (European Union 2010). Human rights, while widely accepted, lack specificity and therefore often need to be translated into more applicable norms. Some of these, such as the UN Global Compact[6] (Leisinger 2007) and other attempts to implement human rights in business organisations (Ruggie 2010) may be more suitable to the implementation of RRI. In addition there are attempts to specify implications of human rights in specific areas, such as the UNESCO Draft Code of Ethics for the Information Society,[7] which may provide the normative basis of RRI.

While the search for established and codified sources of norms is understandable and may help implementation of RRI, it is important to note that there is a plethora of further norms that can inform RRI activities. The most obvious source of norms is the millennia-old discourse on philosophical ethics, which includes well-established positions such as virtue ethics, deontology or theology. It furthermore includes a large number of more recent developments that range from feminist ethics (Gilligan 1990(first edn 1982); Wajzman 2010) to more

application-oriented approaches such as the capability approach (Nussbaum 2011; Sen 2009). There are numerous examples of applications of such ethical theories which may be applicable to RRI. This includes principles of research ethics which, in turn, are based on the Declaration of Helsinki and related documents (World Medical Association 2008). In addition to the principles of research ethics one can observe the set of moral values that are intrinsically linked to science and research but that do not necessarily affect the treatment of human subjects (Singer and Vinson 2002). Given the problem of uncertainty that underlies RRI, one principle which is cited, particularly in European contexts, is the precautionary principle (Gardiner 2006; John 2010). In the light of this extensive landscape of ethical theories and moral values that can inform RRI, one can observe attempts to categorise and classify these to make them more amenable to application to research and innovation activities (Brey 2012a, 2012b; Wright 2011).

There is a set of values that are implied or expressed in principles of governance. The key governance principle that informs the principles and practices of RRI is that of democracy (Gutmann 2011). Reference to democracy explains key aspects of RRI such as: public engagement, the emphasis on grand challenges, and the principle of broad accountability. Governance principles resulting from democracy with likely relevance to RRI include transparency (Zhang et al. 2011), and regulatory parsimony (Gutmann 2011). The reference to democracy may be helpful in that it points towards a higher-level formal principle that can allow the combination of material norms and provide a framework of the different levels of abstraction that always pervade normative questions (Stahl 2012). At the same time this reference to democracy is problematic because it does not normally spell out which aspects of democracy may lead to the solution of the normative questions. A deeper analysis would need to engage with the question of which model of democratic governance can lead to the agreement on normative foundations. For example, there is almost unanimous agreement that participative activities in research and innovation should form part of RRI. At the same time the question of why this is so and how it can be achieved remains open. Participation as a mechanism of research and innovation governance can run counter to established mechanisms of representative democracy. On a practical level, it is not clear how participation in research and innovation is to be organised (e.g. should it happen on a project level, on a programme level, who is responsible for it), who should participate or how participation is to be evaluated.[8] This example support the earlier thesis that RRI can draw on a rich array of extant discourses but that the way these come together is currently not clear. This is the reason why this paper suggests an novel definition of RRI.

2.3 RRI as meta-responsibility

Having outlined the key activities, actors and normative foundations of RRI, this paper can now return to the proposed definition:

> RRI is a higher level responsibility or meta-responsibility that aims to shape, maintain, develop, coordinate and align existing and novel research and innovation-related processes, actors and responsibilities with a view to ensuring desirable and acceptable research outcomes.

The earlier discussion has demonstrated that there is a plethora of activities, actors and norms that in many cases are already configured as existing responsibility relationships. One can thus argue that RRI is not so much a novel type of responsibility, but is best understood as a meta-responsibility, i.e. a responsibility for the maintenance, development and coordination of existing responsibilities. RRI can draw on the responsibilities implied or executed in the above list. Its novelty lies in the fact that it coordinates existing responsibilities and improves the conditions of their successful discharge or execution. From this perspective it is clear that privacy is a core component of RRI.

This definition of RRI draws on a vast body of literature on the concept of responsibility in philosophy, jurisprudence and elsewhere. Very briefly this paper posits that responsibility stands for the determination of the relationship between somebody or something that is responsible (the subject of responsibility) with somebody or something they are responsible for (the object of responsibility). This responsibility relationship between subject and object is based on normative positions and normally has manifest consequences in the form of positive or negative sanctions (Fischer 1999; Stahl 2004). The point here is that there are many responsibilities which have already been defined in research and innovation (e.g. the responsibility of the funder for efficient allocation of resources, the responsibility of the researcher for research integrity etc.) but at present, these are not coordinated and aligned to cover the larger societal challenges that RRI is meant to address.

3 Privacy and RRI

Privacy is not a new concern (Warren and Brandeis 1890) but it is gaining in recognition and relevance. To a significant degree this is caused by the ever-wider spread of information and communication technologies (ICTs) which offer new ways of collecting and linking data which, in turn, can cause privacy concerns. The convergence of technologies (Grunwald 2007) and the integration of ICT in other technologies is likely to exacerbate this problem.

Privacy is thus a key concern that RRI should address. At the same time privacy demonstrates many of the problems that RRI faces. There are conceptual challenges related to the definition of privacy. Due to the prospective interest of RRI, privacy raises epistemological questions.

How can we know future uses of technologies and their possible privacy implications? This leads to the question of the changing nature of privacy preferences. The extent and value of privacy needs have changed significantly in the past and may well continue to do so. In the light of these uncertainties there is the subsequent question of how privacy can be safeguarded.

While privacy demonstrates the challenges of RRI, it also provides an important example of how research, innovation and technology-based questions can be addressed. There are a number of assessment and foresight activities as well as related methodologies that include a specific sensitivity towards privacy issues. Examples would be the DIODE methodology to address future ICT issues (Harris et al. 2011) which suggests these stages: Define questions, Issue analysis, Options evaluation, Decision determination, Explanations dissemination, or the Software Development Impact Statement (Gotterbarn and Rogerson 2005) framework. In addition to these more generalist approaches, there are specific approaches to identifying and addressing privacy concerns such as a privacy impact assessment (Clarke 2009; Information Commissioner's Office 2009) or an ethics impact assessment (Wright 2011).

Privacy has led to the development of methodologies aimed at integrating privacy into research and innovation activities, notably the idea of privacy by design (Gürses et al. 2011; Hoven et al. 2012; Information Commissioner's Office 2008).

Furthermore, privacy is probably the best developed issue with which to demonstrate the role and strategies of legislation and regulation to address RRI issues. In Europe privacy is now recognised as a human right. The European privacy directive (95/46/EC), subsequent national legislation and the current review of this entire system with a view of developing a unified European General Data Protection Regulation shows the importance attributed to privacy by legislators. It furthermore shows that there are ways of democratically regulating contested technology-related issues, which is a core requirement of RRI (European Group on Ethics in Science and New Technologies 2012).

To give an example, imagine a collaborative research project on a mobile biometric security device for online banking applications. Actors with responsibility for privacy in such a project might include the policy-makers who approved a call, funders who administer the budget, researchers who adhere to professional standards or end user organisations which represent user interests. These subjects of responsibility could discharge their responsibilities by including technology foresight, implementing value-sensitive design or privacy by design, or using methodologies from constructive TA. Their shared normative commitment could refer to specific legal requirements, such as the European data protection framework, but also to a broader goal of improving the greater good of society or minimising the potentially negative

impact of end user perception on the acceptance of the technology.

This brief discussion has shown that privacy is related to all three of the dimensions of RRI outlined above: activities, actors and normative foundations. The web of responsibilities that RRI needs to master and organise in order to contribute to the desirability and acceptability of research and innovation is intrinsically linked to privacy in many ways. This leads to the final section of the paper that will look at the limitations of RRI and ways forward.

4 Conclusions and ways forward

This paper has argued that RRI is best conceptualised as a meta-responsibility that draws on and develops the underlying web of existing and novel responsibilities. It is based on the implicit assumption that achieving the acceptability and desirability of research and innovation would be desirable and is, at least to some degree, achievable. Despite this positive starting point it is important to realise that RRI raises numerous questions. It is linked to fundamental epistemological limitations that arise from its reliance on knowledge of the future. There is a danger that RRI leads to or implies technocracy or technological determinism. It touches on millennia-old controversies in moral philosophy and the difficult question of what counts as a good life or a good society. Even if all of these problems can be overcome, it is still clear that RRI will bring to the surface the contradictory positions held by different stakeholders, that may be impossible to mediate. It is probably safe to predict that a broader roll-out of RRI, as intended by the European Commission, will lead to resistance by a number of stakeholders.

It is therefore important to stress that RRI is no panacea. It will not be able to prevent all the negative consequences of research and innovation. It will not remove the need to have controversial debates about desirable futures and the role that research and innovation can play in them. Research and innovation will continue to raise ethical and social challenges and privacy will be a core concern. RRI should be seen as a way to make better decisions on contested questions. In this spirit, RRI will be a resource of creativity that will allow stakeholders to improve the quality of debate and thereby contribute to better and more standardised decisions about contested developments.

The definition of RRI as a meta-responsibility represents an important contribution to the overall RRI discourse. The elevation of RRI to a meta-level, i.e. a level above the individual responsibilities that already exist or need to be developed, sets it apart as a novel way of approaching innovation governance. This procedural definition of RRI is compatible with the other definitions discussed earlier and is open to the inclusion of the numerous material aspects included in the definitions put forward by von Schomeberg, Sutcliffe, Grunwald and others. It leaves open the question as to which components or activities of RRI are most appropriate in a particular innovation context. By focusing on the meta-level it clearly signals that there is an aspect of novelty in RRI, but that this is on the level of coordinating and aligning responsibilities.

4.1 The future of RRI and privacy

The discussion of privacy and RRI points to a number of activities that can support the successful development and implementation of RRI. RRI as a meta-responsibility should be of a reflective nature (Stahl et al. 2013; Stahl 2004). This means that it is part of RRI to consider and reflect upon its own assumptions, presuppositions and required consequences. Assumptions need to be made explicit and rendered open to discussion. With regards to privacy such open reflection of assumptions would need to cover current disagreement on the concept and the question why and to what degree privacy is desirable or required.

On the other hand RRI as a reflective responsibility refers to reflections on the question of implementation. Implementation will most likely need to be based on a broader framework of RRI. Such a framework will most likely include legislation and regulation, institutions, as well as individual guidance, in order to facilitate many of the points made above. In addition, it is likely to require substantive guidance on particular technologies, questions or issues that will allow stakeholders to develop principles and standards of good practice and integrate these into research and innovation processes.

The danger of RRI is not so much a lack of options but the temptation to re-invent activities and processes that have long been established. Active reflexivity should help to avoid this trap. There will likely be more than one flavour of RRI. One can already see in the literature some differences that one could characterise as 'strong' and 'weak' RRI. Strong in this sense would stand for direct responsibility ascriptions leading to manifest sanctions. Contributions to the RRI discourse that directly reference concepts of responsibility and thereby imply the relevance of institutions and sanctions can generally be counted as 'strong' in this sense (e.g. Grunwald 2011). 'Weak' positions allude to views that would support responsiveness (e.g. Von Schomberg 2011) but refrain from discussing the consequences and sanctions linked to RRI. Both of these may have a legitimate role to play and active reflexivity should help the community of researchers understand the merits of different approaches.

To summarise, one could say that the debate on RRI is unfolding rapidly. Privacy is a core constituent of this debate, partly because privacy is a key issue linked to much current research and innovation, partly because the field of privacy research and regulation is highly developed and may provide pointers for dealing with similar

problems. This paper has proposed a novel definition of RRI as a higher-level or meta-responsibility and pointed to the need for the incorporation of reflexivity into RRI itself. This will require the development of a theory of meta-responsibility and ways of displaying and understanding the networks of responsibilities that already exist in research and innovation. The concept of privacy is likely to be central in developing such a theory due to its well-established history in both conceptual and empirical research as well as legislation and regulation.

5 Funding

Acknowledgements

Notes

1. See also Owen and Goldberg (2010) and the UK EPSRC's research project on a 'Framework for Responsible Research and Innovation in ICT' <www.responsible-innovation.org.uk> accessed 9 September 2013.
2. See <http://www.nwo.nl/nwohome.nsf/pages/NWOP_7XREMY> accessed 14 January 2012.
3. See <http://www.gpo.gov/fdsys/pkg/PLAW-108publ153/html/PLAW-108publ153.htm> accessed 14 November 2012.
4. See <http://www.nwo.nl/nwohome.nsf/pages/NWOA_73HBPY_Eng> accessed 14 November 2012.
5. See, for example the UK concordat to support research integrity <http://www.universitiesuk.ac.uk/Publications/Pages/concordattosupportresearchintegrity.aspx> accessed 11 November 2012.
6. See <http://www.unglobalcompact.org/> accessed 16 November 2012.
7. See <http://portal.unesco.org/ci/en/ev.php-URL_ID=24935&URL_DO=DO_TOPIC&URL_SECTION=201.html> accessed 16 November 2012.
8. For a more detailed analysis of the participation of civil society organisations in research governance see the CONSIDER project <www.consider-project.eu> accessed 9 September 2013.

References

Bauman, Z. (2000) *Liquid Modernity*. Cambridge, UK: Polity Press.

Beck, U. (1986) *Risikogesellschaft. Auf dem Weg in eine andere Moderne*. Frankfurt, Germany: Suhrkamp.

Bellucci, S. and Joss, S. (eds) (2002) *Participatory Technology Assessment: European Perspectives*. London: Centre for the Study of Democracy, University of Westminster.

Brey, P. A. E. (2012a) 'Anticipatory ethics for emerging technologies', *NanoEthics*, 6: 1–13. doi:10.1007/s11569-012-0141-7.

—— (2012b) 'Anticipating ethical issues in emerging IT', *Ethics and Information Technology*, 14: 305–17. doi:10.1007/s10676-012-9293-y.

Cagnin, C., Amanatidou, E. and Keenan, M. (2012) 'Orienting European innovation systems towards grand challenges and the roles that FTA can play', *Science and Public Policy*, 39: 140–52.

Clarke, R. (2009) 'Privacy impact assessment: Its origins and development', *Computer Law and Security Review*, 25: 123–35. doi:10.1016/j.clsr.2009.02.002.

Council of the European Union. (2012) *Proposal for Regulation of the European Parliament and of the Council laying down the rules for the participation and dissemination in 'Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)' - Partial General Approach*, (No. Interinstitutional File: 2011/0399 (COD)). Brussels: Council of the European Union.

Cuhls, K. (2003) 'From forecasting to foresight processes: New participative foresight activities in Germany', *Journal of Forecasting*, 22/2-3: 93–111. doi:10.1002/for.848.

Decker, M. and Ladikas, M. (eds) (2004) *Bridges Between Science, Society and Policy: Technology Assessment - Methods and Impacts*. Heidelberg, Germany: Springer.

European Commission. (2011a) *Establishing Horizon 2020 - The Framework Programme for Research and Innovation (2014-2020)* (No. COM(2011) 809 final). Brussels: European

Commission <http://ec.europa.eu/research/horizon2020/pdf/proposals/proposal_for_a_regulation_of_the_european_parliament_and_of_the_council_establishing_horizon_2020_-_the_framework_programme_for_research_and_innovation_(2014-2020).pdf#view = fit&pagemode = none> accessed 26 December 2012.

——. (2011b) *Horizon 2020: The Framework Programme for Research and Innovation* (No. SEC(2011) 1427 final). Brussels: European Commission <http://ec.europa.eu/research/horizon2020/pdf/proposals/communication_from_the_commission_-_horizon_2020_-_the_framework_programme_for_research_and_innovation.pdf#view = fit&pagemode = none> accessed 26 December 2012.

European Group on Ethics in Science and New Technologies. (2012) *Ethics of Information and Communication Technologies* (Opinion of the EGE No. 26) (p. 136). Brussels: Bureau of European Policy Advisors <http://ec.europa.eu/bepa/european-group-ethics/docs/publications/ict_final_22_february-adopted.pdf> accessed 23 March 2012.

European Union. (2010) Charter of Fundamental Rights of the European Union, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri = OJ:C:2010:083:0389:0403:EN:PDF> accessed 11 August 2010.

Fischer, J. M. (1999) 'Recent work on moral responsibility', *Ethics*, 110: 93–139.

Fisher, E., Mahajan, R. L. and Mitcham, C. (2006) 'Midstream modulation of technology: governance from within', *Bulletin of Science, Technology and Society*, 26: 485–96. doi:10.1177/0270467606295402.

Gardiner, S. M. (2006) 'A core precautionary principle', *Journal of Political Philosophy*, 14: 33–60.

Genus, A. and Coles, A.-M. (2005) 'On constructive technology assessment and limitations on public participation in technology assessment', *Technology Analysis and Strategic Management*, 17: 433–43. doi:10.1080/09537320500357251.

Gilligan, C. (1990) *In a Different Voice: Psychological Theory and Women's Development*, (reissue). Cambridge, MA: Harvard University Press.

Gotterbarn, S. and Rogerson, S. (2005) 'Responsible risk analysis for software development: Creating the software development impact statement', *Communications of AIS*, 15: 730–50.

Grunwald, A. (2007) 'Converging technologies: Visions, increased contingencies of the conditio humana, and search for orientation', *Futures*, 39: 380–92. doi:10.1016/j.futures.2006.08.001.

—— (2009) 'Technology assessment: Concept and methods'. In: Gabbay, D. M., Meijers, A. W. M., Woods, J. and Thagard, P. (eds) *Philosophy of Technology and Engineering Sciences*, Vol 9, pp. 1103–46. Amsterdam: North Holland.

—— (2011) 'Responsible innovation: Bringing together technology assessment, applied ethics, and STS research', *Enterprise and Work Innovation Studies*, 7: 9–31.

Gürses, S., Troncoso, C. and Diaz, C. (2011) 'Engineering privacy by design', Paper presented at the Fourth Conference on Computers, Privacy and Data Protection, held 25–7 January 2011, Brussels.

Gutmann, A. (2011) 'The ethics of synthetic biology: Guiding principles for emerging technologies', *Hastings Center Report*, 41/4: 17–22.

Habermas, J. (2007) *Der philosophische Diskurs der Moderne: Zwölf Vorlesungen*. Frankfurt, Germany: Suhrkamp.

Harris, I., Jennings, R. C., Pullinger, D., Rogerson, S. and Duquenoy, P. (2011) 'Ethical assessment of new technologies: A meta-methodology', *Journal of Information, Communication and Ethics in Society*, 9: 49–64. doi:10.1108/14779961111123223.

Hinde, R. A. (2008) *Bending the Rules: The Flexibility of Absolutes in Modern Life: The Twenty-first Century Morality*. Oxford, UK: OUP.

Hoven, J. van den, Helbing, D., Pedreschi, D., Domingo-Ferrer, J. *et al.* (2012) 'FuturICT - The road towards ethical ICT'. *arXiv*:1210.8181 <http://arxiv.org/abs/1210.8181> accessed 14 November 2012.

Information Commissioner's Office. (2008) *Privacy by design*, <http://www.ico.gov.uk/upload/documents/pdb_report_html/privacy_by_design_report_v2.pdf> accessed 24 August 2009.

Information Commissioner's Office. (2009) *Privacy Impact Assessment Handbook*, v. 2.0 <http://www.ico.gov.uk/upload/documents/pia_handbook_html_v2/files/PIAhandbookV2.pdf> accessed 24 August 2009.

John, S. (2010) 'In defence of bad science and irrational policies: An alternative account of the precautionary principle', *Ethical Theory and Moral Practice*, 13: 3–18.

Leisinger, K. M. (2007) 'Capitalism with a human face: The UN global compact', *Journal of Corporate Citizenship*, 28: 113–32.

Manders-Huits, N. and Van den Hoven, J. (2009) 'The need for a value-sensitive design of communication infrastructures'. In: Sollie, P. and Düwell, M. (eds) *Evaluating New Technologies: Methodological Problems for the Ethical Assessment of Technology Developments*, pp. 51–62. Heidelberg, Germany: Springer.

Martin, B. R. (2010) 'The origins of the concept of "foresight" in science and technology: An insider's perspective', *Technological Forecasting and Social Change*, 77: 1438–47. doi:10.1016/j.techfore.2010.06.009.

Nussbaum, M. C. (2011) *Creating Capabilities: The Human Development Approach*. Cambridge, MA: Harvard University Press.

Owen, R. and Goldberg, N. (2010) 'Responsible innovation: A pilot study with the U.K. Engineering and Physical Sciences Research Council', *Risk Analysis: An International Journal*, 30: 1699–707. doi:10.1111/j.1539-6924.2010.01517.x.

——, Macnaghten, P. and Stilgoe, J. (2012) 'Responsible research and innovation: From science in society to science for society, with society', *Science and Public Policy*, 39: 751–60.

Rowe, G. and Frewer, L. J. (2005) 'A typology of public engagement mechanisms', *Science, Technology and Human Values*, 30: 251–90. doi:10.1177/0162243904271724.

Ruggie, J. (2010) *Business and Human Rights: Further Steps toward the Operationalization of the 'Protect, Respect and Remedy' Framework* (Report of the Special Representative of the Secretary-General on the Issue of Human Rights and Transnational Corporations and Other Business Enterprises, UN Doc A/HRC/11/13). Geneva: UN.

Sardar, Z. (2010) 'The namesake: Futures; futures studies; futurology; futuristic; foresight—What's in a name?' *Futures*, 42: 177–84. doi:10.1016/j.futures.2009.11.001.

Schot, J. and Rip, A. (1996) 'The past and future of constructive technology assessment', *Technological Forecasting and Social Change*, 54: 251–68. doi:10.1016/S0040-1625(96)00180-1.

Sen, A. (2009) *The Idea of Justice*. London: Allen Lane.

Singer, J. and Vinson, N. G. (2002) 'Ethical issues in empirical studies of software engineering', *IEEE Transactions on Software Engineering*, 28: 1171–80. doi:http://doi.ieeecomputersociety.org/10.1109/TSE.2002.1158289.

Stahl, B. C. (2004) *Responsible Management of Information Systems*. Hershey, PA: IGI Publishing.

—— (2012) 'Morality, ethics and reflection: A categorisation of normative research in IS research', *Journal of the Association for Information Systems*, 13: 636–56.

——, Eden, G. and Jirotka, M. (2013) 'Responsible research and innovation in information and communication technology: Identifying and engaging with the ethical implications of ICTs'. In: Owen, R., Heintz, M. and Bessant, J. (eds) *Responsible Innovation*, pp. XX–XX. Chichester, UK: Wiley.

Sutcliffe, H. (2011) *A report on Responsible Research and Innovation*, <http://www.matterforall.org/pdf/RRI-Report2.pdf> accessed 11 September 2012.

Von Schomberg, R. (ed.) (2011) *Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields*. Luxembourg: Publications Office of the European Union <http://ec.europa.eu/research/science-society/document_library/pdf_06/mep-rapport-2011_en.pdf> accessed 23 November 2011.

—— (2012) 'Prospects for technology assessment in a framework of responsible research and innovation'. In: Dusseldorp, M. and Beecroft, R. (eds) *Technikfolgen abschätzen lehren: Bildungspotenziale transdisziplinärer Methoden (2012 edn)*, pp. 39–61. Wiesbaden, Germany: VS Verlag für Sozialwissenschaften.

—— (2013) 'A vision of responsible research and innovation'. In: Owen, R., Heintz, M. and Bessant, J. (eds) *Responsible Innovation*, pp. 51–74. Chichester, UK: Wiley.

Wajzman, J. (2010) 'Feminist theories of technology', *Cambridge Journal of Economics*, 34: 143–52. doi:10.1093/cje/bep058.

Warren, S. D. and Brandeis, L. D. (1890) 'Right to privacy', *Harvard Law Review*, 4: 193.

World Medical Association. (2008) *Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects* <http://www.wma.net/en/30publications/10policies/b3/17c.pdf> accessed 23 August 2012.

Wright, D. (2011) 'A framework for the ethical impact assessment of information technology'. *Ethics and Information Technology*, 13: 199–226. doi:10.1007/s10676-010-9242-6.

——, Gellert, R., Gutwirth, S. and Friedewald, M. (2011) 'Precaution and privacy impact assessment as modes towards risk governance'. In: Von Schomberg, R. (ed.) *Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields*, pp. 83–97. Luxembourg: Publications Office of the European Union, <http://ec.europa.eu/research/science-society/document_library/pdf_06/mep-rapport-2011_en.pdf> accessed 16 November 2012.

Zhang, J. Y., Marris, C. and Rose, N. (2011) *The Transnational Governance of Synthetic Biology - Scientific uncertainty, crossborderness and the 'art' of governance* (No. 4). London: London School of Economics and Political Science <http://www2.lse.ac.uk/BIOS/publications/Working%20Papers/WP4TransnationalGovernance.pdf> accessed 6 October 2012.