



## Stop re-inventing the wheel: or how ELSA and RRI can align

Mark Ryan & Vincent Blok

**To cite this article:** Mark Ryan & Vincent Blok (2023): Stop re-inventing the wheel: or how ELSA and RRI can align, Journal of Responsible Innovation, DOI: [10.1080/23299460.2023.2196151](https://doi.org/10.1080/23299460.2023.2196151)

**To link to this article:** <https://doi.org/10.1080/23299460.2023.2196151>



© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 21 Apr 2023.



Submit your article to this journal [↗](#)



View related articles [↗](#)



View Crossmark data [↗](#)

## Stop re-inventing the wheel: or how ELSA and RRI can align

Mark Ryan <sup>a</sup> and Vincent Blok<sup>b</sup>

<sup>a</sup>Wageningen Economic Research, Wageningen University and Research, Wageningen, Netherlands;

<sup>b</sup>Philosophy Department, Wageningen University and Research, Wageningen, Netherlands

### ABSTRACT

Ethical, Legal and Social Aspects (ELSA) originated in the 4th European Research Framework Programme (1994) and responsible research and innovation (RRI) from the EC research agenda in 2010. ELSA has received renewed attention in European funding schemes and research. This raises the question of how these two approaches to social responsibility relate to one another and if there is the possibility to align. There is a need to evaluate the relationship/overlap between ELSA and RRI because there is a possibility that new ELSA research will reinvent the wheel if it does not engage with the body of literature already present in RRI research. This provides unneeded extra bureaucracy, reformulations of research agendas, extra investment, and an overabundance of frameworks to implement, and ELSA research does not take advantage of the body of research developed in RRI. This paper evaluates how ELSA and RRI diverge, are complementary, and can be aligned.

### ARTICLE HISTORY

Received 19 October 2022

Accepted 23 March 2023

### KEYWORDS

Responsible innovation;  
ethics; social responsibility;  
ELSA

## Introduction

The attention to Ethical, Legal and Social Aspects (ELSA) of Research and Innovation (R&I) originated in 1994 in the 4th European Research Framework Programme. As it was being used in research programmes funded by the European Commission (EC), an academic debate around ELSA research also emerged. Similarly, responsible research and innovation (RRI) was adopted and integrated into the EC research agenda in 2010. While policy discussions focussed on RRI as a policy instrument to address a collection of priorities, including gender balance, open access, and stakeholder engagement in the European Community, a research community was also built around what is often shortened to simply responsible innovation (RI) over the past 13 years, culminating in a considerable body of scientific concepts, methods and tools. However, others have argued that an RI academic discourse predates RRI policy discourses; see, for instance (Randles, Tancoigne, and Joly 2022; Shanley 2021; Wiarda et al. 2021). Although we are aware that both concepts often take on their own distinctive debates and challenges

**CONTACT** Mark Ryan  mark.ryan@wur.nl  Wageningen Economic Research, Wageningen University and Research, Wageningen, Netherlands

© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group  
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

(Owen and Pansera 2019; Timmermans and Blok 2021), we will use RRI throughout the paper for consistency.

ELSA has recently received renewed attention in several European funding schemes and the creation of ELSA labs, i.e. laboratory settings where not technical design but ethical, legal and social aspects of new and emerging technologies can be addressed. An example is the funding initiative for artificial intelligence (AI) ELSA labs from the AiNed programme of the Netherlands AI Coalition (Van Veenstra, van Zoonen, and Helberger 2021). The programme aims to develop and deploy a wide diversity of responsible and human-centric AI labs in the Netherlands (Van Veenstra, van Zoonen, and Helberger 2021). The labs work with approaches such as ‘societal readiness levels’ and ‘pathways to impact’, and to ensure human and public values are incorporated (Van Veenstra, van Zoonen, and Helberger 2021). This has already led to 23 ELSA labs being established throughout the Netherlands, with the prospects of many more being created in the coming years from huge investments from the Dutch government. Strangely enough, there is no reference to the body of literature in the RRI domain that can support ELSA research.

In addition to this large funding initiative by the Dutch government, there has been a renewed resurgence of academic papers on the application of ELSA to new topics where it was not traditionally applied, such as mobile symptom checker applications (Müller et al. 2022), precision medicine (Alvarez, Griessler, and Starkbaum 2022), AI technology use in surgery (Wilhelm et al. 2022), and brain computer interfaces for people with disabilities (Chandler et al. 2022). There are also open calls for journal special issues on ELSA applications, such as COVID-19 vaccine acceptance (Piltch-Loeb 2023) and funding calls for ELSA in neuroscience (ERA-NET Neuron 2023). Meanwhile, ELSA working groups are popping up around Europe, such as the German Stem Cell Network (German Stem Cell Network 2023); ELSA data use in Germany (NFDI 2023); and ELSA objectives in the UNESCO recommendations for ethical AI (AI Ethics Global Perspectives 2023).

The renewed attention to ELSA may indicate another cycle in research policy where ELSA and RRI compete for usage in national and transnational policy. This becomes already visible in the new framework programme Horizon Europe, in which there is no longer room for a dedicated research line around Science With And For Society (SWAFS) and the call for RRI research is often integrated into technical calls on new and emerging technologies in Horizon Europe. This shift is important to consider because research frameworks provide guidance to those working in R&I and the humanities/social science community. While there are and have been other approaches developed within EU research and policy that incorporate some of the social impact and stakeholder engagement dimensions of ELSA and RRI, such as constructive technology assessments (CTA), they have not played such a major role as both of these approaches in policy discussions or normatively setting the agenda for EU R&I in the same way. It must also be noted that RRI and ELSA are not set in stone, but are subject to policy debates in which they compete for dedicated funding (for example, the SWAFS programme has ceased, which was a major source of funding for RRI research), and with competing approaches, such as open science (Novitzky et al. 2020).

In this paper, we examine two approaches that largely focus on socially-responsible practice in research and innovation. On the one hand, it might be argued that RRI

research can benefit from the renewed attention for ELSA, as ELSA might be better able to serve the integration of technical and social scientific/humanities research in Horizon Europe. On the other, there is the risk that ELSA reinvents the wheel if it doesn't engage with the body of literature in RRI, as is the case in the new Dutch-funded research on ELSA. This is problematic for policy because it provides unneeded extra bureaucracy, reformulations of research agendas, extra investment required to integrate a new approach, and an overabundance of frameworks to implement (e.g. in addition to the EC-endorsed RRI). It also runs the risk of not taking advantage of the large body of research that has already been developed by the corresponding approach. With these issues in mind, we are interested in identifying whether there is a complementarity between ELSA and RRI and where they can reinforce and strengthen one another.

In our effort to identify complementary features, we are not assuming that ELSA and RRI are inflexible realities. Concepts are not 'things', but are always 'in the making' by their use, application, and competition with other concepts. What is implied in concepts such as ELSA and RRI is not necessarily the same as what is put into practice, in both scholarship and funding organisations. Although there are issues that make such a comparison difficult, it is nonetheless important to conceptually analyse these two approaches insofar as they occupy potentially competing positions in both policy and scholarly discourse. Concepts are not neutral, but shaped by reality. For example, RRI may have originated as a top-down concept from the EC research framework programme Horizon 2020 debates, but it was shaped by the research community, which further reshaped the Horizon Europe debates on RRI. Therefore, the re-emergence of a concept, such as ELSA, might indicate a conceptual shift that we as an RRI community are interested in, what to learn from, and take benefit from.

As authors of this paper, we come from the RRI debate and enter the ELSA domain because of its re-emergence within Dutch policy and 23 AI ELSA labs. It is expected that a considerable stream of funding becomes available for more projects in the ELSA domain from the same funding sources. These formally recognised research labs, as well as the influx of growth within the domain of ELSA, has led the authors to postulate how ELSA would relate to RRI, which is currently a strong research area within the scientific community. One of the goals of this paper is to assess whether this reemergence of ELSA will cause a re-inventing of the wheel when it comes to many of the topics and themes already robustly discussed in RRI.

There has already been work done in the area of evaluating RRI against ELSA (see Zwart, Landeweerd, and Van Rooij 2014; Forsberg 2014; Rip 2014). Some authors don't see the need for RRI in addition to ELSA (Myskja et al. 2014) while other see them as complementary (Ofstedal 2014). In most cases, the relation between ELSA and RRI has been evaluated from the view of why RRI was used to replace ELSA, and less to do with how the two approaches may align with one another. As a special issue of *Life Science, Society and Policy* on this topic (Forsberg 2015) presciently suggests, the current rehabilitation of ELSA in the policy debate raises questions anew and, particularly from a policy perspective, points to the importance of comparing and contrasting these approaches. For instance, while ELSA originally did not take economic stakeholders and perspectives into account, as it was mainly focussed on fundamental research and less on practical applications and private innovation contexts, the current attention for ELSA, at least in the Dutch context, explicitly involves an economic perspective. Here

it might be that ELSA can learn from RRI, as RRI has a much stronger practical focus and increasingly considers economic perspectives as well (Long and Blok 2021). For this reason, we build upon Zwart et al.'s analysis of ELSA, but move on from simply critiquing the replaceability of ELSA with RRI to instead engaging with an evaluation of how the two approaches can be aligned so as to reinforce one another.

Therefore, this paper evaluates the ELSA and RRI positions and how they may reinforce and strengthen one another. It is important to analyse commonalities as well as differences, especially where differences can highlight potential weaknesses in each approach. The primary aim of this paper is to identify how the RRI debate can reinforce the ELSA debate and vice versa. This paper is a conceptual comparison of the ELSA and RRI concepts to identify how both concepts can strengthen one another. It is not meant as an extensive systematic review of the abundance of literature that has been written on both approaches. We are aware of the fact that there are many different approaches to ELSA and RRI found within the literature, but our goal is to simply contrast two of the most well-known examples of both approaches (that by Zwart, Landeweerd, and Van Rooij 2014 for ELSA and Stilgoe, Owen, and Macnaghten 2013 for RRI) to see how they may potentially strengthen one another. We are aware that there are many differences and variations that we cannot address in this more general paper, but we hope that based upon the findings of our paper that it will inspire future research by providing an initial outline of how the two approaches intersect and diverge.

The paper will begin by providing an overview of ELSA (Section 1) and RRI (Section 2), and an analysis of some of the main commonalities between the two positions (Section 3). Section 4 will examine the main divergences between RRI and ELSA and how their differences can help reinforce and strengthen both positions.

## **Ethical, legal, and social aspects (ELSA)**

The origin of ELSA cannot be discussed without also mentioning its predecessor, ELSI (ethical, legal, and social implications). The relationship between ELSI and ELSA is very close and the latter materialised as a result of the former (Zwart and Nelis 2009). Both stand for the ethical, legal, and social implications (for ELSI) or aspects (for ELSA) of research, scientific activity, innovation, or new technologies. ELSI emerged from the United States, while ELSA in Europe. ELSI was first created in 1989 to respond to, and tackle, issues arising in science and emerging technologies, specifically about the life sciences (primarily, human genomics), which was followed by the European ELSA (Fisher 2005; Lewenstein and Brossard 2006; Rip 2009; Yesley 2008).

ELSA was first introduced in 1994, in the 4th European Union (EU) Framework Programme. It was initially developed as a top-down 'funding mechanism', but it later became the approach used by research communities to ensure greater ethical and societal care was implemented in scientific research (Zwart and Nelis 2009). Research communities saw the added value of implementing an ELSA approach within their work and adopted its aims regardless of the link to the EU Framework Programme (Rodríguez, Fisher, and Schuurbiens 2013). It became widely used and known throughout the 90s (especially as a result of its early use in the human genome project) and the early 2000s (Van Veenstra, van Zoonen, and Helberger 2021).

ELSI and ELSA typically refer to the same thing (Zwart and Nelis 2009) and there appears to be no clear methodological difference, except for the name and emphasis (i.e. implications versus aspects). It may be claimed that ‘implications’ have a more negative connotation and typically refers to harmful implications that need to somehow be resolved, or ‘a unidirectional causal relationship between technology and society is possible’ (Van Veenstra, van Zoonen, and Helberger 2021, 3). ‘Aspects’ are sometimes taken to be more neutral, and can also include both negative and positive ethical, legal, and social, aspects of technology. Our focus is on ELSA because of the renewed interest and application of this approach.

ELSA originated in the early 90s in response to the view that science and technologies needed to consider their work’s societal implications (Zwart and Nelis 2009). As the acronym states, ELSA focuses specifically on three areas: ethical, legal, and social. While it does not specifically attach these three areas to specific disciplines, the disciplines of ethics, law, and sociology, respectively, would appear to be highly relevant. However, ELSA could also be applied to other disciplines, such as anthropology, political science, science and technology studies (STS), and cultural studies. Overall, ELSA looks at the future output of research and innovation (R&I) and what ethical, legal, and social aspects this would entail.

The practice of ELSA was adopted and integrated into many different framework programmes for research, such as: the Research Council of Norway and ELSAGEN (a transnational research programme between Germany, Austria and Finland) (Chadwick and Zwart 2013; Zwart, Landeweerd, and Van Rooij 2014, 1–2); the United Kingdom ELSA centres through the Economic and Social Research Council’s Genomics Network (Chadwick and Zwart 2013); and the Netherlands Genomics Initiative (NGI), which aimed to examine the societal aspects of genomics research (Zwart, Landeweerd, and Van Rooij 2014). ELSA was also applied in many different contexts, such as the European Defence Program, bio and neurotechnology, nanotechnology, and robotics (Van Veenstra, van Zoonen, and Helberger 2021; Zwart and Nelis 2009).

These ELSA applications opened up opportunities for furthering research into the societal impacts of science and technology. However, they emphasised that science alone does not have all of the answers and there is a need for public participation to answer the societal dimensions of such research. Essentially, the practice of ELSA brought together many different stakeholders under one roof, such as policymakers, non-governmental organisations (NGOs), scientists, and the general public. The aim was to create a dialogue among an array of stakeholders to identify the ethical, legal, and social aspects of science and technology. One of the main reasons for this is that much of this research is executed by universities and funded by citizens via their tax payments, so they should have a say in what it is used for (Zwart, Landeweerd, and Van Rooij 2014).

Secondly, as the public will be the ones impacted by such scientific and technological developments, it is important to identify what they need and want from research conducted in these areas. ELSA veered away from simply accepting the views of the expert as fact; instead, it stated that researchers should be open to involvement and dialogue with the public. ELSA focused on bringing the public into the discourse around how scientific and technological advancements can benefit society. It allowed the public to voice their concerns, fears, and apprehensions.

The fundamental components of ELSA are outlined by Zwart and Nelis (2009) in Table 1.

As can be seen in Table 1, ELSA aims to promote inclusion and stakeholder involvement, create synergies between disciplines, ensure that it is being practically implemented in science, and anticipate potential issues and ensure that they are responsibly dealt with. These features of the original ELSA concept can also be recognised in contemporary ELSA approaches, for example, the Netherlands AI Coalition supports these four ELSA features, stating that they should be incorporated within the ELSA projects funded by the Dutch government (NL AI Coalition 2020).

It is not completely clear why the Netherlands AI Coalition chose to adopt the ELSA approach over other socially-responsible approaches. The Coalition envisions the ELSA labs as part of a drive toward ‘human-centred AI’, which aims to place greater control into human hands during the development and use of AI (i.e. to not allow AI to make decisions without human control over the AI’s decisions). The Coalition also states that by the introduction of ELSA laboratories, research and innovation projects in the area of AI help to ensure responsible and human-centred AI. These AI ELSA labs can be seen as ‘social co-creation environments in which, together with citizens, companies, knowledge institutions and the government, it is investigated how AI can contribute to the shaping of our society’ (NL AI Coalition 2020).

It is initiatives such as this one, and the examples given in the introduction, that has been the driver of the research for this paper. As there is significant money and effort being poured into new lines of ELSA research, it is important to reflect upon approaches that are already in existence that focus on many of the same aspects of ELSA. RRI is an approach that proposes to do many of things that ELSA does. Therefore, it is important to identify if these new initiatives, such as the NL AI Coalition’s ELSA labs, is reinventing the wheel by overlooking RRI. The following section will outline the RRI approach before going into a comparative evaluation of both approaches.

## Responsible research and innovation (RRI)

RRI was implemented in European-funded research projects around 2011/2012 (the first workshop on RRI in Brussels was 16–17 May 2011) and an influential paper by Stilgoe, Owen, and Macnaghten (2013) helped set the stage for RRI as a major focus of academic research. RRI emerged in large part from a European drive toward ensuring greater responsibility and attention to societal aspects within EC-funded scientific research projects (Randles, Tancoigne, and July 2022; Wiarda et al. 2021). In the beginning, RRI was mainly focused on public research (Blok and Lemmens 2015) and was used in many European Commission-funded research projects; later it expanded so as to place a stronger emphasis on private sector innovation as well (Blok, Hoffmans, and Wubben 2015, 2020).

**Table 1.** Four features of an ELSA approach (Zwart and Nelis 2009).

---

### Four Features of an ELSA Approach

---

1. Proximity/participation: embeddedness of ELSA research in scientific programmes
  2. Anticipate: early anticipation of issues and those responsible for dealing with these issues
  3. Interactivity: encourage stakeholders and the public to assume a more active role in co-designing research agendas
  4. Interdisciplinarity: to bridge the boundaries between research communities such as bioethics and STS.
-

RRI was first coined in 2010 and was a term used by the European Union's Framework Programme to describe a research focus on the societal impacts of scientific and technological research projects in the EU (Randles, Tancoigne, and Joly 2022; Von Schomberg 2013; Wiarda et al. 2021). It aimed to align research and innovation (R&I) policies with societal goals (Stilgoe, Owen, and Macnaghten 2013; Sutcliffe 2011). RRI focuses on allowing societies to make decisions in relation to R&I policy, while taking into account the needs of society (Orbit RRI 2022). It aims to initiate socially-responsible methods to achieve this and also to socially-responsible outcomes as a result.

A significant example of RRI comes from the EU's RRI 'keys,' which are Ethics, Science Education, Gender Equality, Open Access, Governance and Public Engagement (Randles, Tancoigne, and Joly 2022; Rip 2016; Zwart, Landeweerd, and Van Rooij 2014). These keys were developed by the EU to work as ways to give shape to the European scientific research community through their framework programmes. However, others have claimed, to the contrary, that the keys were essentially a strategic arrangement of funding programme categories and 'were not clearly related to RRI' (Rip 2016, 290). Regardless of the legitimacy of the claim that the keys represent RRI principles, an effect of their establishment was the endorsement of the RRI keys as being an important topic for EU research and policy.

One of the leading proponents of RRI, Von Schomberg (2013) describes RRI as

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 (to allow a proper embedding of scientific and technological advances in our society) (Von Schomberg 2013).

von Schomberg describes RRI as a way to incorporate different stakeholders in a discursive process to allow scientific and technological development to be assisted by societal considerations and values. Dialogue about ethical and societal issues should be conducted with an array of relevant stakeholders and not simply confined to social scientists. In addition, social scientists should enter the dialogue with life scientists, engineers, and business owners, at a much earlier stage in the research life-cycle.

Since von Schomberg's early definition of RRI, many more have come (Asveld et al. 2017; Hoven 2014; Koops et al. 2015; Timmermans and Blok 2021). However, one approach that has been used as the cornerstone definition of RRI is the four process dimensions outlined in (Stilgoe, Owen, and Macnaghten 2013; Stilgoe, Owen, and Macnaghten 2013) (see Table 2).

Stilgoe, Owen, and Macnaghten 2013 state that RRI is fundamentally concerned with 'taking care of the future through collective stewardship of science and innovation in the present' (Stilgoe, Owen, and Macnaghten 2013). These four process dimensions have been extensively used throughout RRI research, being applied in many different contexts and applications. Stilgoe, Owen, and Macnaghten 2013 also reiterate the Horizon 2020 framework programme line dedicated to SWAFS (Novitzky et al. 2020). They claim that RRI should have three specific features: science for society; science with society; and reframing responsibility. Science for society places a greater emphasis on the importance of scientific development for the common good and not simply for commercial success, prestige, and economic growth (Owen, Macnaghten, and Stilgoe 2020). Science with society reflects upon the need to institutionalise societal impact assessments

**Table 2.** Four process dimensions outlined in Stilgoe, Owen, and Macnaghten (2013).Four Process Dimensions in Stilgoe, Owen, and Macnaghten (2013)

1. Anticipation refers to evaluating and identifying potential societal impacts of scientific and technological research. It anticipates uncertainties and their possible outcomes.
2. Reflexivity focuses on the impacts, purposes, and motivations of this research and innovation (R&I) and postulates how society will be affected by different potential outcomes.
3. Inclusion aims to identify and include stakeholders that may be affected by these possible outcomes. It focuses on including diverse perspectives in an attempt to arrive at amenable solutions for these stakeholders.
4. Responsiveness refers to implementing suitable action based on the findings of the other three processual dimensions.

and ethical evaluations with scientific development, along with being reflexive, anticipatory, and adaptive to scientific and technological development (Owen, Macnaghten, and Stilgoe 2020). Finally, reframing responsibility places a wider diversity of responsibility onto those working within science and technology to not only abide by what they should avoid, but also, what they should initiate for the benefit of society (Owen, Macnaghten, and Stilgoe 2020). We will use this outline by Stilgoe, Owen, and Macnaghten 2013 as our main source of comparison of RRI with ELSA.

### Strengthening RRI and ELSA

ELSA and RRI both emerged – at least to a significant degree – from top-down research funding institutions (Zwart, Landeweerd, and Van Rooij 2014). The two approaches were largely shaped, developed, and implemented by funding bodies to evaluate societal aspects of scientific and technological research. Both approaches focus on the context of European public-funded research projects to ensure that attention is given to social and ethical concerns regarding such research. EU-public funding supported both approaches (Zwart, Landeweerd, and Van Rooij 2014, 15).

As can be seen from the above descriptions of ELSA and RRI, participation, involvement, and inclusion of a wide diversity of stakeholders are fundamental principles in both approaches. ELSA and RRI are intended to better align scientific research and technological developments with public participation and deliberation to ensure the values and needs of society are fulfilled. In fact, Zwart, Landeweerd, and Van Rooij 2014 suggest that many of the main objectives of RRI amount to those outlined in ELSA, for example:

considering societal needs and ethical aspects in research funding programs, e.g. through public and stakeholder dialogue; developing criteria for the early appraisal of research and innovation, e.g. technology assessments; establishing processes to better integrate societal needs in research and innovation, e.g. trans-disciplinary approaches in sustainability science; setting up advisory bodies such as councils on ethical aspects of new technologies (Zwart, Landeweerd, and Van Rooij 2014, 14).

Clearly, ELSA and RRI endeavour to implement societal evaluations of scientific and technological development, through greater dialogue, participation, and early intervention, throughout the research and innovation process. Therefore, at first glance, the two approaches appear to be similar in a number of respects, with convergent aims and goals, and similar means to achieve them.

And yet, despite the congruency between the two approaches, closer inspection shows that both approaches are quite different from one another, once one scratches beneath

the surface and delves into how they define and approach their different features. For the purpose of this paper, and for comparative reasons, we will focus on two aforementioned highly-renowned works on ELSA and RRI: Zwart and Nelis 2009; and Stilgoe, Owen, and Macnaghten 2013. This section will focus on the four main features of the ELSA approach (Zwart and Nelis 2009) and how they relate to the four RRI process dimensions (Stilgoe, Owen, and Macnaghten 2013) (see Table 3).

While these two papers and their respective features do not represent *all* ELSA and RRI, they are often seen as some of the most prominent works in their fields. We will occasionally refer to other works that differ in their understanding and descriptions of ELSA and RRI, which may offer alternatives and different insights into the features and process dimensions discussed below. The following sections will outline commonalities and differences between these two papers' treatments of the features and process dimensions. It will demonstrate how these differences provide an opportunity to reflect on potential challenges common to both approaches and to reinforce and strengthen one another. It will use the ELSA features and RRI process dimensions as a basis to compare this evaluation, and a way to illustrate some of these similarities and differences. This section will be divided into sections on Anticipation and ethics; Inclusion and interactivity; Participation and Interdisciplinarity; Responsiveness; and Negotiation and Solutionism.

### **Ethics and anticipation**

While both RRI and ELSA anticipate and reflect on ethical and societal impacts of R&I, they appear to be based on different ethical approaches. One can derive from ELSA research focus and descriptions that it leans more towards a position of moral intuitionism (Hare 1997; Ross and Ross 2002; Sidgwick 2019), accepting that there are specific morally self-evident rights and wrongs in the world, but also that most ethical analysis needs to be done in the context of specific examples and cases, rather than having an overarching top-down approach that can apply to all cases. ELSA originated out of the need for ethical evaluations of genomics and health research, implementing a more pragmatic approach to ethics, which has a greater focus on evaluating specific cases and examples in real-life, rather than being distracted by hypothetical postulations.

RRI is sometimes criticised because it is more about responsibility in the *political* sense of representation in and democratisation of R&I, in which ethics is merely 'an' aspect whereas socio-political aspects such as power receive much more attention (Pellé and Reber 2015). For example, while the term 'ethics' is mentioned numerous times, the concept itself is not discussed in Stilgoe, Owen, and Macnaghten (2013) and is rarely discussed in other formulations of RRI (Blok 2018; Pellé and Reber 2015).

**Table 3.** ELSA features and RRI process dimensions.

ELSA Features (Zwart and Nelis 2009)	RRI Process Dimensions (Stilgoe, Owen, and Macnaghten 2013)
Anticipation	Anticipation
Interactivity	Inclusion
Participation	Reflexivity
Interdisciplinarity	Responsiveness

The concept of RRI is also sometimes criticised because it lacks an explicit reflection on the notion of ethical responsibility (Blok 2018; Pellé and Reber 2015). While it is often referred to within definitions of RRI, such as von Schomberg's definition and the EC RRI keys, it is often not completely clear what ethical stance is being taken or which traditional normative ethics framework it aligns with. An explication could be the dominance of political scientists and sociologists in the discourse, who see responsibility as a social construction that emerges from practices and processes (Blok 2018; Pellé and Reber 2015).

While ethics is one of the EU RRI keys (ORBIT RRI 2022), its discussion is very limited and solely focuses on ethics in the context of research ethics. Research ethics in turn focuses on ensuring that research is conducted in an ethical manner, usually by implementing standards or rules for researchers to follow and to ensure that research aligns with societal values (Briggle and Mitcham 2012; Mitcham and Englehardt 2019). This is the reason why in the academic debate around RI, it has been called for a more substantial conceptualisation of responsibility in RI Practice (for instance (Blok 2018; Pellé and Reber 2015)).

Another difference between the approaches can be seen in the conceptualisation of ethics. Some argue that ELSA focuses mostly on restrictive aspects of R&I and what ethical, legal and social *harms* should be prevented, whereas RRI views responsibility also as an opportunity, rather than simply an inhibitor, to innovate for the common good. Thus, according to von Schomberg:

What's new about RRI is that we no longer see the ethical aspects of new technologies as constraints and restrictions. Instead, we look at the aims of technology development. Which positive contributions do you wish to obtain from research and innovation? This positive basic attitude is an important difference in comparison with the ELSA approach (Von Schomberg 2012, 16).

von Schomberg implies that ELSA focuses on the negative, restrictive, and impediments to research and innovation, while RRI attempts to embed societal concerns as goals within research and innovation. RRI wants to provide positive ethical contributions to research and innovation (beneficence), to contribute to the common good, as well as an ethics of avoidance of harms (non-maleficence). At the same time, ethics is not really operationalised in practice: in Stilgoe, Owen, and Macnaghten 2013 for example, RRI is often more focused on political issues and 'risks' rather than necessarily ethical issues or rationales in its operationalisation (Rip 2018); and in the EU RRI keys, ethics remains vague/focused on research ethics.

In short, ELSA often focuses on what is wrong with a situation or on how to prevent morally objectionable consequences from occurring, with much less of a focus on positive moral obligations. RRI, in turn, places much more emphasis on redirecting discussions within research and innovation towards positive moral obligations and responsibility (Voegtlin and Scherer 2017). Not only should we be concerned about harms to avoid (non-maleficence), we should also focus on actions we should do to benefit society (beneficence) (Childress and Beauchamp 1979). Both non-maleficence and beneficence are important principles for R&I and should underpin approaches such as RRI and ELSA.

RRI can benefit from ELSA because it could help to substantiate what is meant by ethics in RRI, and by enriching RRI's conceptualisation of ethical and legal aspects

beyond being merely social dimensions. Conversely, as ELSA originally focussed on the restrictive role of anticipation – anticipating potential ethical, legal and social harms as a consequence of R&I – the renewed attention to ELSA and ELSA labs could learn from RRI how the anticipation of ethical, legal and social aspects can also be taken as *opportunities* for responsible design.

### ***Inclusion and interactivity***

Secondly, there is a strong contrast between ELSA and RRI in their emphasis on inclusion and interactivity; they tend to use different terminology and understand these principles in different ways. ELSA and RRI both emphasise the importance of interactivity, which focuses on including and encouraging stakeholders and the public to participate and have an active role in the co-designing of research agendas (interactivity feature). RRI focuses on identifying and including stakeholders that may be affected by scientific and technological developments and aims to include a diverse range of perspectives to arrive at responsible solutions for stakeholders involved (inclusion process requirement).

However, if we consider that, in recent years, RRI covers both public and private R&I and therefore also involves economic stakeholders, while ELSA originally focusses on public R&I, this difference has consequences for the types of stakeholders involved in discussions of ethical and societal dimensions of scientific and technological innovation, and the particular challenges these inclusion and interaction practices face. If economic considerations are given more attention in R&I, then the limitations of transparency in interactions for competitive reasons should be acknowledged (Blok and Lemmens 2015), as actors have to balance legitimate economic objectives and societal objectives (Brand and Blok 2019). RRI therefore integrates industry stakeholders within the dialogue on societal impacts, whereas these stakeholders in ELSA would have much less importance (as a result of a reduced focus on economic valorisation).

It might be that ELSA originally didn't focus on economic actors involved in R&I because of its focus on publicly funded research programmes related to genomics and health. ELSA may be criticised for being less practice oriented, while RRI provides a practice based agenda (Forsberg 2015). Although this might explain why ELSA excludes industrial stakeholders in the debate around ethical, legal, and social aspects of R&I, this position can already be criticised based on the fact that much of the R&I in genomics and health is currently done by private R&I. More importantly, however, is that the renewed attention for ELSA explicitly extends towards the interaction with industry stakeholders, for instance by referring to the Quadruple Helix Collaboration model in which research, policy, industry and civil society stakeholders are involved. In this regard, ELSA research can potentially benefit from the RRI literature on better understanding both challenges and promising methods in the inclusion of stakeholders in Quadruple Helix Collaborations in general (Popa et al. 2020), and the inclusion of economic actors in particular (Blok, Hoffmans, and Wubben 2015).

### ***Participation and interdisciplinarity***

ELSA states that the ELSA aspects should be embedded within scientific programmes in which new and emerging technologies are researched and developed. While this

embeddedness is endorsed by RRI advocates (for example, as discussed in the quotes from von Schomberg earlier), it often fails to materialise in practice in RRI. One reason for this difference may come from the difference in the scope of analysis of both approaches. ELSA primarily focuses on specific aspects and case studies where science and technology is being researched, developed, and implemented. As a result, it concentrates on the micro-analysis of the *specific* ethical, legal and social aspects of R&I practices, rather than the macro-analysis of the *general* RRI dimensions (Zwart and Nelis 2009).

ELSA promotes interdisciplinarity and it was one of the earliest examples of practically and efficiently integrating humanities' disciplines within the field of life science and technological research (Forsberg 2014; Zwart, Landeweerd, and Van Rooij 2014; Zwart and Nelis 2009). It provides a platform for humanities researchers to converse and integrate their knowledge within life sciences and technological development, aiming to provide a mutually beneficial learning experience between social and life scientists and engineers (Forsberg 2014; Zwart, Landeweerd, and Van Rooij 2014; Zwart and Nelis 2009).

Both ELSA and RRI have a very similar group of humanities and social science researchers working on this topic, namely, STS scholars, political scientists, ethicists, legal scholars, and sociologists. However, ELSA has a much greater diversity of researchers participating in projects in practice (e.g. the inclusion of social scientists with life scientists, rather than mostly different strands of social scientists) (Zwart, Landeweerd, and Van Rooij 2014). ELSA also emphasises that scientists should be informed about the societal impacts of their work and to collaborate with social scientists to better understand these implications (Rip 2009; Rip 2018).

While RRI literature explicitly encourages and promotes the participation of scientists and engineers in the governance of responsible R&I, this is much less evident in practice than other approaches such as Open Science (Shelley-Egan, Gjefsen, and Nydal 2020). Thus, there is a tension between the theoretical exposition of RRI and the realisation of it in practice. While the implementation of RRI in policy and funding programmes encourages developing RRI *competencies for* scientists, their engagement within the *development of* these competencies with RRI researchers is lacking (for a thorough examination of the challenges of the institutionalisation and embeddedness of it in practice, please see Owen et al. 2021).

RRI literature has witnessed an expansion of this (mostly) social science group of researchers to include business and marketing researchers (Blok, Hoffmans, and Wubben 2015, 2020; Blok and Lemmens 2015), which are not often discussed in ELSA research. This allows for a greater reflection on the business components and how societal considerations can be effectively integrated within private funded R&I (Ntsondé and Aggeri 2017). Especially because the renewed attention for ELSA research in ELSA labs explicitly involves economic stakeholders (NL AI Coalition 2020), ELSA research can benefit from this aspect of RRI interdisciplinarity.

In addition, the absence of a dedicated SWAFS programme line in Horizon Europe means that future RRI research requires a degree of practicality and implementability of the participatory approach in tangible examples and case studies of R&I practices. Likewise, while it is important to focus on specific case studies of how ELSA can be implemented in real-life participation, it is also valuable to zoom out from the cases and research general interventions and tools that can be implemented in participatory

ELSA labs. Therefore, both approaches' scope of analysis can benefit from one another, rather than being a limiting or divisionary aspect of RRI and ELSA.

ELSA research can benefit from the RRI literature if it comes to the governance of ELSA labs and interventions to assess ELSA and identify participatory opportunities for responsible R&I, while RRI research can benefit from the ELSA literature if it comes to the participation of scientists and engineers in the governance of responsible R&I.

### **Responsiveness**

It could be argued that responsiveness is a part of RRI that is less present in ELSA than many of the other process dimensions. Because ELSA aims for the implementation of suitable actions based on the findings of ELSA research, it can be claimed that ELSA is responsive to particular ethical, legal and social concerns, while the broader responsiveness to issues like societal desirability and sustainability (Von Schomberg 2013) are considered less. von Schomberg explicitly argues that RRI focusses on the (ethical) acceptability, sustainability and societal desirability of the innovation process *and its marketable products*. In recent RRI literature, the contribution of RRI to the competitive advantage of economic actors is researched (Blok et al. 2020). This RRI literature places a focus on innovation and uses social sciences to examine the life sciences and technology to support these industries, rather than challenge or oppose them. Its 'selling point' is that its use of social examination is to serve competitiveness, and ensuring the continuation, of scientific and technological progress. It achieves this by reducing harmful outcomes and risks, caused by science and technology, to society. Harmful outcomes and risks are seen as impediments to innovation and industry. Responsibility is needed to ensure economic sustainability. It is in researchers' and the industry's interests to implement RRI to counter these potential issues. This difference can be viewed as a positive or a negative; namely, it acknowledges the importance of economic sustainability so it is more pragmatic about real-world issues, thus offering greater a likelihood of implementation in commercial settings. On the other hand, it opens itself to the claim of ethical whitewashing, ensuring business-as-usual, and that ethical issues are only factored in because they are of economic benefit to the company.

Although economic aspects were originally not part of ELSA, economic considerations are not necessarily inconsistent with ELSA requirements. ELSA does not exclude the possibility of economically benefitting from science and technology, for instance to reduce risks and align with societal expectations, nor does it state that there is something inherently wrong with doing so. There could be a number of reasons why economic valorisation is not discussed in ELSA. For example, the economic valorisation of scientific and technological progress is seen as a given that does not necessitate its explicit discussion on ethical, legal, and societal aspects. Or perhaps, the inclusion of economic valorisation will water-down the message of ELSA, veer the discussion towards the economic, or altogether override ELSA components for economic concerns. Although these critical considerations constitute a real challenge that can be observed in the RRI industry literature (Long and Blok 2021), and are valid and deserve dedicated research, since the renewed attention for ELSA involves economic valorisation as well, ELSA research can benefit from insights in RRI in industry research.

An additional issue with the lack of inclusion of economic concerns within ELSA is that there is the potential that ELSA research will anticipate and reflect on ethical, legal, and social aspects of R&I, but this will fall on deaf ears or remain only in the academic textbooks and journals of its niche disciplines. As RRI literature nowadays does include industrial partners, and economic actors have the incentive to translate responsibility into marketable products that have added value for consumers – more privacy, more sustainability etc. – it can be argued that ELSA can benefit from the responsiveness dimension found in RRI literature and that it can add quite a lot that could strengthen the ELSA approach. First, in the sense that new and emerging technologies like AI, digital twins and Internet of Things raise broader societal concerns regarding industrialisation, datafication and surveillance that are not covered at the level of ELSA aspects of particular AI applications. Second, in the sense that the renewed attention for ELSA explicitly involves economic stakeholders and their interest in translating ELSA into marketable products.

Essentially, because ELSA places less of a focus on economic valorisation, and does not explicitly include industry partners, it runs the risk of only being applicable to public research projects and not also in the private sector. ELSA can benefit from the approach taken within RRI, which gives greater focus on the economic sustainability of actions, and taking into account the views of industry partners on how to implement ethical responses in business.

### ***Solutionism and negotiation***

Sometimes, researchers, engineers and innovators claim to take responsibility because they work on technologies that contribute to grand challenges like sustainability or public health. In recent literature, such a ‘solutionist’ approach in RRI, i.e. an approach that legitimises its engagement with RRI because it presents a solution to grand challenges like sustainability, is criticised (Ludwig et al. 2022). The argument is that R&I is not only responsible if the solution contributes to grand challenges, for instance if this solution is mainly informed by dominant or powerful actors while other or weaker actors are not taken into account, or if it is not sufficiently reflected on the ethical acceptability or societal desirability of this solution together with multiple stakeholders.

Solutionism is criticised in favour of the ‘negotiation’ strategy, that acknowledges the negotiation process in which heterogeneous and often conflicting value frames are at stake (Ludwig et al. 2022). Although both the solutionist and negotiation approach have their benefits and one could argue that a combination of both strategies is ideal, science and engineering practices are criticised if they purely focus on solutionism, i.e. claiming that because a new technology contributes to sustainability, and we don’t have to consider these heterogeneous value frames and viewpoints of various stakeholders involved.

Based on this distinction between the solutionist and negotiation strategy, one could criticise the ELSA approach for running the risk of solutionism, because of its focus on the assessment of the ELSA aspects, while not automatically taking the process of innovation that lead to this application into account. This is in line with earlier criticism, that ELSA runs the risk of being an add on to large science and technology development projects (Forsberg 2015). To prevent this risk, ELSA can benefit from the negotiation

strategy that is dominant in RRI research. And vice versa, as RRI research often employs the negotiation strategy, one could argue that RRI can benefit from the solutionist strategy employed by the ELSA approach.

## Discussion and conclusion

Overall, there is a very strong degree of overlap between the ELSA and RRI approaches, both regarding their intention and outcomes. There are few striking dissimilarities or features that would render them in any way incompatible or oppositional. In fact, when certain characteristics are not explicitly found in either approach, they are often implicitly part of that approach's fundamental aims and functions (e.g. interdisciplinarity). In other instances, these missing components in one of the approaches can add and strengthen the other approach where they are missing (e.g. responsiveness in ELSA). While both approaches can certainly still be used on their own, we believe that the two approaches can complement one another and thus we propose a re-formulation of their core characteristics in [Table 4](#).

Our analysis found aspects of the four ELSA characteristics of ELSA – anticipation, interactivity, participation, interdisciplinarity – to be somewhat insufficient to achieve the ambition that is set by the renewed attention for ELSA, and it could be complemented with the inclusion of the characteristics of RRI. Our analysis also proposed that the four characteristics of RRI – anticipation, inclusion, reflexivity, responsiveness – are somewhat insufficient to achieve its goals in EU framework programme Horizon Europe, and could benefit from interacting with ELSA. While both approaches can certainly still function on their own, and perhaps benefit from the insights found in one another, there is also the possibility that they could be re-envisioned together within one uniting approach. This is not meant to disregard or sidestep the foundational research done in both fields, but simply offers another way of viewing the two approaches' relationship together. Therefore, based on these findings, we propose a reinforced ELSA – RRI alignment that builds upon the strengths of each other (see [Table 5](#)).

These features hold the potential to guide future RRI and ELSA practices. For example, in the Dutch AI ELSA lab process, engineers and ELSA-RRI experts should invite quadruple helix stakeholders related to cases of technological design engage in the research and innovation process. As a first step they could evaluate the societal

**Table 4.** ELSA-RRI complementary features.

---

### ELSA-RRI Complementarity

---

1. Ethics and anticipation: ELSA brings ethics back to the centre again, which could benefit RRI. ELSA benefits from RRI by considering ethical aspects as *opportunities* for responsible design.
  2. Inclusion and interactivity: ELSA research benefits from validated RRI approaches for the inclusion of stakeholders in Quadruple Helix Collaborations and the inclusion of economic actors.
  3. Participation and Interdisciplinarity: ELSA benefits from RRI in its governance-focused approach to ELSA aspects, incorporate economic and business disciplines, and to identify opportunities for practical responsible R&I. RRI benefits from ELSA by creating greater interdisciplinarity outside of the humanities (i.e. include life science) and realising its academic ideals of interdisciplinarity in practice.
  4. Responsiveness: ELSA benefits from RRI by expanding its scope toward innovation (including the private sector), which would have a much greater societal impact than if it only concentrates on public research alone.
  5. Solutionism and Negotiation: ELSA can benefit from the negotiation strategy by being more reflexive and adaptable, while RRI can benefit from a more directed and goal-orientated approach, as found within ELSA's solutionism.
-

**Table 5.** ELSA-RRI features.**ELSA-RRI Alignment Features**

1. Ethics and anticipation: Identify and evaluate potential societal impacts and purposes of scientific and technological research, their uncertainties and possible outcomes, and those responsible for dealing with these issues.
2. Inclusion and interactivity: Include diverse perspectives from stakeholders that may be affected by a particular course of actions, and attempt to arrive at amenable solutions for these stakeholders.
3. Participation and Interdisciplinarity: Embed ELSA-RRI researchers in scientific programmes and at early stages of scientific and technological R&I. Ensure participation of natural and social scientists and also industry partners. Bridge the boundaries between different research communities throughout the entire process of scientific and technological R&I.
4. Responsiveness: Implement suitable action, which should entail involvement/liasing with relevant stakeholders (e.g. policymakers, industry, research community, and societal actors).
5. Solutionism and negotiation: Focus on the economic, ethical, legal, and societal impacts of R&I and reflection on how society will be affected by different potential outcomes, through a balance of targeted solutions and open negotiation and compromise.

goals that the technology should serve and how this can be operationalised together. As a second step, these engineers, ELSA-RRI experts and stakeholders closely collaborate, and identify the ELSA-RRI features of the case in general and the ethical challenges in particular in an early design; reflect on and anticipate societal consequences and controversies related to these designs; identify opportunities for responsible and human-centred technological (re)design; translate these opportunities into design requirements; balance these ELSA-RRI features with technological and economic design requirements; and encourage economic actors to integrate ELSA-RRI features in their marketable products. During several cycles of assessment, monitoring and evaluation, which are guided by the 6 ELSA-RRI features identified in this article, the ELSA-RRI features will be integrated in the cases of technological (re)design.

While there has already been work done on the link between RRI and ELSA, our paper offers fresh insights into the debate by examining two of the most-renowned framings of each position (Zwart, Landeweerd, and Van Rooij 2014 for ELSA and Stilgoe, Owen, and Macnaghten 2013) and contrasting how these approaches could benefit from greater alignment. Our paper addresses subtle yet important differences between both approaches and attempts to point the way forward toward how they may align with and strengthen one another. This paper works as a conceptual piece to compare Zwart, Landeweerd, and Van Rooij (2014) and Stilgoe, Owen, and Macnaghten (2013) to identify the content within both approaches, where they vary, and suggestions on room for cohesion. Because our analysis was mostly confined to these two approaches, we are conscious that they may not be representative of all RRI or all ELSA approaches. However, we hope that our findings provide a step and inspiration for further research into the area and how these two very important approaches can benefit each other.

### Disclosure statement

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

### Funding

This work was supported by Horizon 2020 Framework Programme [grant number 101005937]; Nederlandse Organisatie voor Wetenschappelijk Onderzoek [grant number Nwa.1332.20.002].

## Notes on contributors

**Mark Ryan** is a Digital Ethics Researcher at Wageningen Economic Research, focusing on areas of robotics, AI, and digital developments and responsible innovation. He has published on a wide range of digital ethics topics, such as: smart cities, self-driving vehicles, agricultural data analytics, social robotics, and artificial intelligence.

**Vincent Blok** MBA is Professor in philosophy of technology and responsible innovation at the Philosophy Chair Group, Wageningen University. From 2002 to 2006, Blok held various management functions in the health care sector. In 2006, he became director of the Louis Bolk Institute, an international research institute in the field of organic and sustainable agriculture, nutrition and health care. In 2005 he received his PhD degree in philosophy at Leiden University with a specialization in philosophy of technology.

## ORCID

Mark Ryan  <http://orcid.org/0000-0003-4850-0111>

## References

- AI Ethics Global Perspectives. 2023. *Implementing the UNESCO Recommendation on the Ethics of AI*. <https://aiethicscourse.org/webinars/implementing-the-unesco-recommendation-on-the-ethics-of-ai>.
- Alvarez, M. J. R., E. Griessler, and J. Starkbaum. 2022. "Ethical, Legal and Social Aspects of Precision Medicine." In *Precision Medicine in Clinical Practice*, 179–196. Springer.
- Asveld, L., R. van Dam-Mieras, T. Swierstra, S. Lavrijssen, K. Linse, and J. van den Hoven. 2017. *Responsible Innovation 3*. Springer.
- Blok, V. 2018. *Innovation as Ethos: Moving Beyond CSR and Practical Wisdom in Innovation Ethics*. Blok, V., L. Hoffmans, and E. F. M. Wubben. 2015. "Stakeholder Engagement for Responsible Innovation in the Private Sector: Critical Issues and Management Practices." *Journal on Chain and Network Science* 15 (2): 147–164. doi:10.3920/JCNS2015.x003
- Blok, V., E. A. Iñigo, A. Novelskaitė, R. Pučėtaitė, A. A. Adams, K. Wakunuma, T. Jiya, L. Grabner, L. Lorenz, and I. Sánchez de Madariaga. 2020. *Recommendations for the Development of a Competitive Advantage Based on RRI*.
- Blok, V., and P. Lemmens. 2015. *The Emerging Concept of Responsible Innovation. Three Reasons Why It Is Questionable and Calls for a Radical Transformation of the Concept of Innovation* | SpringerLink. doi:10.1007/978-3-319-17308-5\_2.
- Brand, T., and V. Blok. 2019. "Responsible Innovation in Business: A Critical Reflection on Deliberative Engagement as a Central Governance Mechanism." *Journal of responsible innovation* 6 (1): 4–24.
- Briggle, A., and C. Mitcham. 2012. *Ethics and Science: An Introduction*. Cambridge: Cambridge University Press.
- Chadwick, R., and H. Zwart. 2013. "From ELSA to Responsible Research and Promisomics." In *Life Sciences, Society and Policy*, Vol. 9, Issue 1, 1–3. BioMed Central.
- Chandler, J. A., K. I. Van der Loos, S. Boehnke, J. S. Beaudry, D. Z. Buchman, and J. Illes. 2022. "Brain Computer Interfaces and Communication Disabilities: Ethical, Legal, and Social Aspects of Decoding Speech from the Brain." *Frontiers in Human Neuroscience* 163.
- Childress, J. F., and T. L. Beauchamp. 1979. *Principles of Biomedical Ethics*. New York: Oxford University Press.
- ERA-NET Neuron. 2023. *Ethical, Legal, and Social Aspects (ELSA) of Neuroscience*. <https://www.neuron-eranet.eu/joint-calls/elsa/>.
- Fisher, E. 2005. "Lessons Learned from the Ethical, Legal and Social Implications Program (ELSI): Planning Societal Implications Research for the National Nanotechnology Program." *Technology in Society* 27 (3): 321–328. doi:10.1016/j.techsoc.2005.04.006

- Forsberg, E.-M. 2014. "Institutionalising ELSA in the Moment of Breakdown?" *Life Sciences, Society and Policy* 10 (1): 1–16. doi:10.1186/2195-7819-10-1
- Forsberg, E. M. 2015. "ELSA and RRI–Editorial." *Life Sciences, Society and Policy* 11 (1): 1–3.
- German Stem Cell Network. 2023. *Ethical, Legal and Social Aspects*. <https://gscn.org/german-stem-cell-network/strategic-working-groups/elsa>.
- Hare, R. M. 1997. *Sorting Out Ethics*. New York: Clarendon Press.
- Hoven, M. J. 2014. *Responsible Innovation 1: Innovative Solutions for Global Issues*. Springer.
- Koops, B.-J., I. Oosterlaken, H. Romijn, T. Swierstra, and J. van den Hoven. 2015. *Responsible Innovation 2*. Springer.
- Lewenstein, B. V., and D. Brossard. 2006. *Assessing Models of Public Understanding in ELSI Outreach Materials*. Ithaca, NY: Cornell University.
- Long, T. B., and V. Blok. 2021. "Emotional Conflict and Trauma: The Recovery of Stolen Memory Using a Mixed-Methods Approach." *Humanities and Social Sciences Communications* 8 (1): 1–9. doi:10.1057/s41599-020-00684-8
- Ludwig, D., V. Blok, M. Garnier, P. Macnaghten, and A. Pols. 2022. "What's Wrong with Global Challenges?" *Journal of Responsible Innovation* 9 (1): 6–27. doi:10.1080/23299460.2021.2000130.
- Mitcham, C., and E. E. Englehardt. 2019. "Ethics Across the Curriculum: Prospects for Broader (and Deeper) Teaching and Learning in Research and Engineering Ethics." *Science and Engineering Ethics* 25: 1735–1762. doi:10.1007/s11948-016-9797-7
- Müller, R., M. Klemmt, H.-J. Ehni, T. Henking, A. Kuhnmüch, C. Preiser, R. Koch, and R. Ranisch. 2022. "Ethical, Legal, and Social Aspects of Symptom Checker Applications: A Scoping Review." *Medicine, Health Care and Philosophy* 25 (4): 737–755. doi:10.1007/s11019-022-10114-y.
- Myskja, B. K., R. Nydal, and A. I. Myhr. 2014. "We have Never been ELSI Researchers—There is no Need for a Post-ELSI Shift." *Life Sciences, Society and Policy* 10 (1): 1–17.
- NFDI. 2023. *Section: Ethical, Legal, and Social Aspects*. <https://www.nfdi.de/section-elsa/?lang=en>.
- NL AI Coalition. 2020. *Ethical, Legal & Social Aspects (ELSA) Labs Een referentiemodel voor maatschappelijke co-creatie omgevingen t.b.v. De ontwikkeling van zinvolle human centric AI toepassingen*.
- Novitzky, P., M. J. Bernstein, V. Blok, R. Braun, T. T. Chan, W. Lamers, A. Loeber, I. Meijer, R. Lindner, and E. Griessler. 2020. "Improve Alignment of Research Policy and Societal Values." *Science* 369 (6499): 39–41. doi:10.1126/science.abb3415
- Ntsondè, J., and F. Aggeri. 2017. "Building Responsible Innovation Ecosystem, a New Approach for Inter-organizational Cooperation." *EURAM* 2017.
- Oftedal, G. 2014. "The Role of Philosophy of Science in Responsible Research and Innovation (RRI): The case of Nnomedicine." *Life Sciences, Society and Policy* 10: 1–12.
- Orbit RRI. 2022. "About RRI." *Orbit*. <https://www.orbit-rri.org/about/about-rri/>.
- Owen, R., P. Macnaghten, and J. Stilgoe. 2020. "Responsible Research and Innovation: From Science in Society to Science for Society, with Society." In *Emerging Technologies: Ethics, Law and Governance*, edited by Gary E. Marchant, and Wendell Wallach, 117–126. New York: Routledge.
- Owen, R., R. von Schomberg, and P. Macnaghten. 2021. "An Unfinished Journey? Reflections On a Decade of Responsible Research and Innovation." *Journal of Responsible Innovation* 8 (2): 217–233.
- Owen, R., and M. Pansera. 2019. "Responsible Innovation and Responsible Research and Innovation." In *Handbook on Science and Public Policy*. Edward Elgar Publishing. [https://www.elgaronline.com/view/edcoll/9781784715939/9781784715939.00010.xml?utm\\_campaign=JPE14808&utm\\_medium=cms&utm\\_source=CPB](https://www.elgaronline.com/view/edcoll/9781784715939/9781784715939.00010.xml?utm_campaign=JPE14808&utm_medium=cms&utm_source=CPB).
- Pellé, S., and B. Reber. 2015. "Responsible Innovation in the Light of Moral Responsibility." *Journal on Chain and Network Science* 15 (2): 107–117. doi:10.3920/JCNS2014.x017
- Piltch-Loeb, R. 2023. "Special Issue 'COVID-19 Vaccine Acceptance: Ethical, Legal and Social Aspects (ELSA)'" *Vaccines*. [https://www.mdpi.com/journal/vaccines/special\\_issues/ethical\\_legal\\_social\\_COVID\\_19\\_vaccines](https://www.mdpi.com/journal/vaccines/special_issues/ethical_legal_social_COVID_19_vaccines).

- Popa, E. O., V. Blok, and R. Wesslink. 2020. "A Processual Approach to Friction in Quadruple Helix Collaborations." *Science and Public Policy* 47 (6): 876–889.
- Randles, S., E. Tancoigne, and P.-B. Joly. 2022. "Two Tribes or More? The Historical Emergence of Discourse Coalitions of Responsible Research and Innovation (rri) and Responsible Research and Innovation (RRI)." *Journal of Responsible Innovation* 9 (2): 248–274. doi:10.1080/23299460.2022.2061306
- Rip, A. 2009. "Futures of ELSA." *EMBO Reports* 10 (7): 666–670. doi:10.1038/embor.2009.149
- Rip, A. 2014. "The Past and Future of RRI." *Life Sciences, Society, and Policy* 10.
- Rip, A. 2016. "The Clothes of the Emperor. An Essay on RRI in and Around Brussels." *Journal of Responsible Innovation* 3 (3): 290–304. doi:10.1080/23299460.2016.1255701
- Rip, A. 2018. "The Past and Future of RRI." In *Futures of Science and Technology in Society*, 115–133.
- Trigué, H., E. Fisher, and D. Schuurbiens. 2013. "Integrating Science and Society in European Framework Programmes: Trends in Project-level Solicitations." *Research Policy* 42 (5): 1126–1137. doi:10.1016/j.respol.2013.02.006
- Ross, D., and W. D. Ross. 2002. *The Right and the Good*. Oxford: Oxford University Press.
- Shanley, D. 2021. "Imagining the Future Through Revisiting the Past: The Value of History in Thinking About R(R)I's Possible Future(s)." *Journal of Responsible Innovation* 8 (2): 234–253. doi:10.1080/23299460.2021.1882748
- Shelley-Egan, C., M. D. Gjefsen, and R. Nydal. 2020. "Consolidating RRI and Open Science: Understanding the Potential for Transformative Change." *Life Sciences, Society and Policy* 16 (1): 7. doi:10.1186/s40504-020-00103-5
- Sidgwick, H. 2019. *The Methods of Ethics*. New York: Good Press.
- Stilgoe, J., R. Owen, and P. Macnaghten. 2013. "Developing a Framework for Responsible Innovation." *Research Policy* 42 (9): 1568–1580. doi:10.1016/j.respol.2013.05.008
- Sutcliffe, H. 2011. "A Report on Responsible Research and Innovation." *MATTER and the European Commission*.
- Timmermans, J., and V. Blok. 2021. "A Critical Hermeneutic Reflection on the Paradigm-level Assumptions Underlying Responsible Innovation." *Synthese* 198 (19): 4635–4666. doi:10.1007/s11229-018-1839-z.
- Van Veenstra, A. F., E. A. van Zoonen, and N. Helberger. 2021. *ELSA Labs for Human Centric Innovation in AI*.
- Voegtlin, C., and A. G. Scherer. 2017. "Responsible Innovation and the Innovation of Responsibility: Governing Sustainable Development in a Globalized World." *Journal of Business Ethics* 143 (2): 227–243. doi:10.1007/s10551-015-2769-z.
- Von Schomberg, R. 2012. *See Ethics as a Stimulus, not as an Obstacle*. Interview LEV 8.
- 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 Richard Owen, John R. Bessant, and Maggy Heintz, 51–74. West Sussex: John Wiley & Sons, Ltd.
- Wiarda, M., G. van de Kaa, E. Yaghmaei, and N. Doorn. 2021. "A Comprehensive Appraisal of Responsible Research and Innovation: From Roots to Leaves." *Technological Forecasting and Social Change* 172: 121053. doi:10.1016/j.techfore.2021.121053
- Wilhelm, D., R. Hartwig, S. McLennan, S. Arnold, P. Mildner, H. Feußner, T. Neumuth, and R. Bieck. 2022. "Ethical, Legal and Social Implications in the Use of Artificial Intelligence-based Technologies in Surgery: Principles, Implementation and Importance for the User." *Der Chirurg; Zeitschrift Fur Alle Gebiete Der Operativen Medizin*.
- Yesley, M. S. 2008. "What's ELSI Got to Do with It? Bioethics and the Human Genome Project." *New Genetics and Society* 27 (1): 1–6. doi:10.1080/14636770701843527
- Zwart, H., L. Landeweerd, and A. Van Rooij. 2014. "Adapt or Perish? Assessing the Recent Shift in the European Research Funding Arena from 'ELSA' to 'RRI'." *Life Sciences, Society and Policy* 10 (1): 1–19. doi:10.1186/s40504-014-0011-x
- Zwart, H., and A. Nelis. 2009. "What is ELSA Genomics?" *EMBO Reports* 10 (6): 540–544. doi:10.1038/embor.2009.115