International Handbook on Responsible Innovation — a Global Resource

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I am writing this review after re-reading the *International Handbook on Responsible Innovation — a Global Resource* during one of the many lockdowns imposed by governments around the world in response to the COVID-19 pandemic. Looking up from the book from time to time to watch the daily news of the ongoing but gradually changing discussions concerning both the virus and the measures to prevent its spread gives me the benefit of hindsight when stress-testing the concepts and practices of responsible research and innovation described in the handbook against how they actually fared in the case of a pandemic.

As we look back at how the COVID-19 pandemic moved around the world in waves, we notice significant changes in the perception that individuals have of the pandemic and in the subsequent responses of communities both to the virus itself and to the regional prevention measures. Naturally — and also as stated very clearly in the context of Responsible Research and Innovation (RRI) discussed in the handbook — the initial perception and responses depended just as strongly on the prevalent regional cultural/societal settings, as their change was influenced by both the actions of the local decision-makers and the effect of the SARS-CoV-2 virus on the local community. Nevertheless, scientists all over the world were starting to

observe and celebrate an increase of trust in science, predicting that the pandemic would mark a step-change in the role of research and innovation as widely recognised enablers of a safer and better future. Alas, this transformation proved short-lived, as the daily news documented the metamorphosis of the profession of the virologist, who — during the first wave — became overnight a ‘chat show’-trekking, veritable superhero of recognised (and in some eyes sole) authority on all matters pertaining to the virus and its prevention, but then evolved to become one of the most publicly hated, death threat-receiving experts. In few countries — at least among those countries whose news I was able to follow more closely from the confinement of my Brussels flat — was this shift as visible as it was in Germany, which, during the first lockdown, was sometimes paraded as an example both of how to tackle the pandemic on a general and of how to engage with the public on a particular level. What was remarkable, however, was the timing of the virologists’ fall from grace, since this did not gain public traction until the first wave had almost fully passed, the lockdown had been lifted to the extent that only very few, light protective measures remained, and people were starting to enjoy an ‘almost normal’ sunny summer.

It will take years to analyse and understand all of the observations, actions, reactions and effects that the COVID-19 pandemic brought about all over the world, and the (change in the) public’s perception of science and innovation and its protagonists is no exception. Giving the complex field of virology (and epidemiology) a

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human face and encouraging direct dialogue between its experts and the public were unquestionable exemplary good practice (not only in the context of RRI); it remains to be established, however, how that celebrated trust could have been better maintained (not only in my example case of Germany). The *International Handbook on Responsible Innovation — a Global Resource* describes many such concepts and practices of Responsible (Research and) Innovation that were applied during the pandemic, enabling all of us to gauge the observable widespread progress in developing and adopting R(R)I as an important pillar of the foundations of science, technology and innovation worldwide. And while observations generally seem to indicate that the pandemic did indeed spur some research and innovation activities of unprecedented speed and successful results thereof (not least in the form of vaccines), we should turn to the handbook for guidance on how to embark now on a new area of increased importance of research and innovation.

The Story of Responsible (Research and) Innovation in 36 Chapters

The *International Handbook on Responsible Innovation — a Global Resource* does what it says on the tin: it is a true reference source that provides both facts about Responsible Innovation (RI) and examples of its implementation in a number of different cultural settings.

Not aiming to represent a specific view or opinion, the handbook allows the 58 (co-)authors of its 36 chapters to follow their own narratives in the descriptions of concepts, (regional) societal contexts, and technology- and region-specific implementation practices of RI examples. Some authors have chosen to adopt the terminology ‘Responsible Research and Innovation’ (RRI), which describes a specific approach coined by the Framework Programmes for research of the European Union (EU), and which was formally implemented as one of the ‘cross-cutting issues’ in the 2014–2020 Framework Programme (Horizon 2020), particularly in the work programme on the topic of ‘Science with and for Society’ (SwafS).¹ Indeed, the widening from RI to

RRI does not constitute any breach of the scope of the handbook, which is introduced by René von Schomberg as ‘a truly global resource on the subject matter of interdisciplinary research and activity’; instead, it enriches the reader’s understanding of responsibility as a process (of engagement (with researchers, citizens, policy makers, industries, third sector organisations, etc.), transparency, open access, gender and minority equality and ethics, to name but a few of the practices of real-world implementation of R(R)I), presented in this reference book in 36 chapters.

The handbook is structured in five main parts:

- Part I outlines the different concepts underpinning R(R)I that stem from (a) responsibility and ethics, (b) governance and (c) responsible innovation in organisations: Concepts underpinning responsible innovation.
- Part II describes R(R)I’s role beyond scientific and technological disciplines, and its responsibility in addressing the right impacts in local, regional and specific cultural contexts: Responsible innovation — becoming responsive to the global societal challenges.
- Part III demonstrates a number of advanced R(R)I practices in the context of the specific technologies they had been designed for and applied to: Embedding responsible innovation in emerging technological practices
- Part IV counterposes the technology-specific examples of the previous part with R(R)I practices that are regionally and culturally sensitive: Regional practices
- Part V provides the transcript of three in-depth interviews with prominent representatives from within the practitioner community of R(R)I: Interviews

In his introductory chapter, the co-editor René von Schomberg provides the historical, political and societal context of the development of the concept of R(R)I as a logical (and necessary) response to ‘six deficits in the global research and innovation system’:

1. ‘Exclusive focus on risk and safety issues concerning new technologies under governmental regulations’,
2. ‘Market deficits in delivering on societal desirable innovations’,

¹ Science with and for Society (SwafS) (Horizon 2020): <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/science-and-society> (accessed: February 2021).

3. ‘Aligning innovation with broadly shared public values and expectations’,
4. ‘A focus on the responsible development of technology and technological potentials rather than on responsible innovation’,
5. ‘A lack of open research systems and open scholarship as a necessary, but not sufficient condition for responsible innovation’, and
6. ‘Lack of foresight and anticipative governance for the alternative shaping of innovation in sectors’.

In doing so, he takes the reader back to Brussels in the early 2000s, when Europe was experiencing the fallout of public perception following the introduction to the wider public of biotechnology as a discipline and of genetically modified organisms (GMOs) in food products as one of the first examples of its commercialisation; the ensuing public disapproval of biotechnology as a discipline, and the policy-makers’ knee-jerk reaction of regulating biotechnological processes, continued to cause long-term damage to Europe as a location for biotechnology research and innovation.² At that very time, when science, technology and innovation communities around the world were formulating an understanding of what had gone wrong in the biotechnology debate, and what definitely not to do next time around, nanotechnology emerged as a celebrated new general purpose technology (GPT); as a result of both the coincidence of its entry and its soon hyped potential to impact all existing markets and to possibly create new ones, nanotechnology automatically became a formidable pilot line and test bed for a range of new concepts that aimed to introduce responsibility and reflexivity into the very nature of research and innovation processes, in order to prevent renewed widespread opposition to an entire field of science and technology. Around the globe, declarations, principles, strategies and codes

were developed that aimed to revolutionise the process of research and innovation from the bottom up. Von Schomberg’s introduction discusses the most influential and transformative of these policies and policy implementation measures, thereby referring to the corresponding examples of R(R)I practices described in the handbook; it is not surprising that most of these are set in Europe, where the backlash against genetic modification/engineering had been most pronounced, and where the European Commission, at the request of the Council,³ adopted the Precautionary Principle⁴ in early 2000, which was subsequently found by the EU Court of Justice to be definable as ‘a general principle of Community law requiring the competent authorities to take appropriate measures to prevent specific potential risks to public health, safety and the environment, by giving precedence to the requirements related to the protection of those interests over economic interests’.⁵ The Precautionary Principle, which is now applied by many jurisdictions around the world, marked the introduction of a hard legal basis for the development of a wide range of concepts of R(R)I; many of these, such as the concept of FAIR (findability, accessibility, interoperability and reusability)⁶ data are still in their infancy, while others, such as the concept of ‘open access to scientific publications’,⁷ remain the subject of controversy.

² It is too early to speculate about silver linings while the COVID-19 pandemic continues to cause havoc to the world over, killing many people every day, and damaging or threatening the lives and livelihoods of millions of others, but the success and rapid deployment of the first effective vaccines against COVID-19 may (hopefully) mark the beginning of the redemption of biotechnology as a discipline of good and trusted science in Europe.

³ EU Council resolution calling upon the European Commission to be even more determined in the future to be guided by the precautionary principle in preparing proposals for legislation [...]: [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999Y0721\(01\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999Y0721(01)) (accessed: February 2021).

⁴ Communication from the Commission on the precautionary principle: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52000DC0001> (accessed: February 2021).

⁵ Judgment in the case of *Artegoda v. Commission* of 26 November 2002, (T-74/00), paragraph 184: <http://curia.europa.eu/juris/document/document.jsf?text=&docid=47533&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=93524> (accessed: February 2021).

⁶ (a) FAIR data: https://en.wikipedia.org/wiki/FAIR_data#cite_note-FAIR_principles_2016-1; (b) FAIR Principles (by the GO FAIR Initiative): <https://www.go-fair.org/fair-principles/> (accessed: February 2021).

⁷ Open access to scientific publications: https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor/trends-open-access-publications_en (accessed: February 2021).

Nanotechnology — a Field Day for STS-Scholars

Due to the coincidence with the emergence of the GPT nanotechnology, the handbook presents a number of its concepts and practices through examples that are routed in experiments or initiatives linked to the process of nanoscience and/or -technology, demonstrating how the emerging technology became a field day for science and technology studies (STS) scholars around the globe. This highlights the handbook's nature as a true source of reference that enables the reader to transfer the R(R)I practices in the described regional, societal, cultural and technological settings to other contexts, and thereby to reflect on the differences that emerge, in the same way that I am re-reading the handbook today, while asking myself how the successful introduction and adoption of R(R)I concepts may have shaped the impacts of both the pandemic and its various spill-over effects. To be more precise, one could ask the following questions: 'Without the introduction of R(R)I, ...

- ... would we have been able to benefit from the same rapid scientific assessment of the virus, its characteristics, epidemiology and its pathobiological effects, as well as from the immediate open sharing of its results around the world?'
- ... would we now be benefitting from the rapid development, authorisation and manufacture of numerous vaccines all over the world, marking an unprecedented hand-in-hand collaboration between universities, industries and governments?'

In the handbook, Richard Owen and Mario Pansera describe the latter observation in their discussion of responsible innovation both in the context and as an object of 'Process and Politics' (Chapter 3): 'To the first and second missions of universities (to teach and to do research) became added a third: to ensure impact from research and for this to be *useful* (economically and socially), often mediated through the construct of the triple helix of government-industry-university interactions. [...] If science and innovation are embedded in politics, so also must RI be.' The co-authors note that 'the role of innovation acquires multiple and often contested functions within which a set of political questions emerge:

- What is innovation (and development) for?
- Who is innovation for?

- Who establishes what problems innovation should or should not address?
- Why are the problems of certain sectors of society privileged, whereas others are completely neglected?
- Who is impacted and how?
- Who wins and who loses?'

The chapter concludes by highlighting von Schomberg's argument for the introduction of 'normatively "right impacts" of innovation [...] at least in Europe, [according to] those enshrined in the European Constitution (for example competitive market economy, sustainable development, and so on).'

What is 'Responsible'? — and if so, How Many?

Contributing to the discussion of 'governance', Miklós Lukovics et al. (Chapter 9) propose a definition for 'responsibility' by describing what it is not: 'We hesitate to call a company responsible just because it does not do something that is prohibited, or because it behaves strictly according to some government prescription.' This delineation demonstrates that responsibility is always dependent on the regulatory framework pertaining to it by defining where the law ends and responsibility starts. Moreover, the exact implementation of responsibility within a given jurisdiction will also depend on product- and/or service-specific cultural and socio-economic factors that determine the feasibility of specific R(R)I practices. Even if clear regulatory boundaries, quantifiable marginal costs, marginal (external) utilities and marginal external benefits are used in this definition, a grey zone remains in those areas, where governmental research and innovation (R&I) funding (through instruments like grants, innovation vouchers, tax advantages) incentivises companies to proactively innovate their products and services to performance benchmarks that lie far beyond the applicable hard regulatory requirements. Does incentivised innovation constitute responsibility, or does true responsibility always require a self-sacrifice (i.e. cost of one's own actions and decisions)? Xavier Pavie offers an answer to this question by noting that 'adopting a responsible approach cannot result in the adoption of a precautionary principle by the organization, as this would inevitably impair performance' (Chapter 15).

Leonhard Hennen and Linda Nierling add the dimension of ‘integration’ to the definition of responsibility by noting that ‘[r]esponsible innovation’s ambition to integrate anticipatory thinking and responsiveness to public concerns in the research process itself is in need of researchers and innovators being prepared to open up their laboratories and research departments to the public’ (Chapter 14). In Chapter 6, however, Kjetil Rommetveit et al. challenge this concept of integration by examining ‘some of the tensions between the ideals and the operationalisation of responsible research and innovation, [resulting in] three (practical and theoretical) lessons for RRI’:

1. ‘Epistemic and normative differences are sources of legitimacy [to (technology) assessments (TA) and their practices]’: the authors describe the two fundamentally different opinions about the level of involvement of STS scholars in scientific research and development processes: while one opinion, which was ‘grounded in networks- and practice-based accounts and imaginations of agency’, ‘warned against TA becoming part of the promise- and wishing-machinery of the very technoscience it is supposed to assess’, the other opinion was described as ‘systems-based [...] as a way of making sense of possibilities for collaborations with others across disciplinary or institutional boundaries’, and promoted a practice of integrating TA and STS scholars into the process of research, innovation and governance, as demonstrated in the specific case of “anticipatory governance”.
2. ‘Interdisciplinarity is a possible outcome, not a premise’: the authors aim to debunk the modern-day view that ‘single disciplines are not up to the task of grasping the cross-cutting and cross-sectoral activities of researchers and innovators’, and that the mobilisation of ‘more disciplines and more perspectives [...] will provide a richer set of assessments, and more adequate policy responses.’
3. ‘Law as a resource and guarantee’: the authors recommend that ‘jurists should not be expected to engage in non-legal evaluations of the proposed and/or contested policies and rules, in forecasting of social, cultural or environmental effects of innovations [...]. They can do so [...], but then

they do not practice law, [but] turn into amateur policy-makers, economists, sociologists, ethicists or, even, amateur engineers.’

Mirroring the Collingridge dilemma’s ‘information problem’,⁸ however, the three lessons listed above highlight one of the ultimate challenges facing R(R)I practitioners: while the growing complexity of scientific and technological concepts, communicated via the medium of limiting languages (and often complicated by the fact that the single language that enables cross-cultural and cross-societal conversations is not the mother tongue of the majority of those using it), makes the involvement of experts with different backgrounds indispensable, active collaborations between such experts tend to encourage an overstepping of disciplinary boundaries and competences.⁹ Alfred Nordmann, whose views are quoted in Chapter 6, provides an excellent discussion of the binding ties of both ‘collective experimentation’ and ‘participatory design’ (or ‘co-design’) in Chapter 12: he illustrates the detrimental shortcomings of both approaches by outlining how, in collective experimentation — unlike in physical experiments — the ‘division between those that conduct the experiment and that which is observed’ is deliberately dissolved, and how any design (thinking) process is ‘taken to be profoundly social’, and ‘does not take “no” for an answer.’ By way of counterposing, the handbook presents Erik Fisher’s detailed description of the idea of ‘integration of social sciences and humanities with research and innovation practices’ in direct succession to Nordmann’s argumentation: in Chapter 13, Fisher introduces the STIR (socio-technical integration

⁸ Collingridge dilemma: https://en.wikipedia.org/wiki/Collingridge_dilemma (accessed: February 2021).

⁹ In 2017, a group at the OECD (Organisation for Economic Co-operation and Development), in collaboration with representatives of the Scientific Foresight (STOA) Unit of the European Parliament, aimed to address this challenge through the development of an extended STEEPED (social – technological – economical – environmental – political/legal – ethical – demographic) approach, orchestrated to gather first-hand input concerning the likely impact of a specific technology application scenario on all STEEPED aspects, while keeping both the participating laypeople and experts in their clearly defined expertise and roles: <https://acumenist.com/assessing-the-impact-of-technology-convergence/> (accessed: February 2021).

research) approach and illustrates its benefits by describing how the problem of ‘expertise as a solution’ (i.e. ‘disciplinary practitioners are competent to make expert pronouncements only in their area of study’) could be overcome by enacting STIR through the coordination of the domains of expertise, while the conundrum of ‘expertise as a problem’ (i.e. ‘the specialised focus of expertise constitutes both its ability to produce knowledge and its inability to account for what lies outside this knowledge’) could be addressed by illuminating STIR through the mutual exploration of these limitations to knowledge. Within the R&I funding regime of the European Union at least, the question of whether to integrate or not to integrate appears resolved (at least for those wishing to receive funding from the EU’s R&I Framework Programme), as outlined by Doris Schroeder and David Kaplan in Chapter 20: ‘Responsible Research and Innovation (RRI) implies that societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society. In practice, RRI is implemented as a package that includes multi-actor and public engagement in research and innovation, enabling easier access to scientific results, the take up of gender and ethics in the research and innovation content and process, and formal and informal science education.’¹⁰

Xavier Pavié’s aforementioned organisation-focussed perspective offers a possible solution to the question of the right level of integration (Chapter 15): he finds that ‘[t]he degree of involvement of each stakeholder depending on their relevance on a particular topic also needs to be examined. [...] Including stakeholders as part of the innovation process management requires structural changes in order to set new guidelines for strategic goals and methods and for managing a complex network of external stakeholders.’ Advancing these considerations to the question of ‘how collaboration partnership processes in CSR [corporate social responsibility] and RI have to be conceived’, Vincent Blok

(Chapter 16) notes that a ‘cognitive level of the agreement on a joint problem definition, common ground or shared objective among multiple stakeholders [...] is often difficult to achieve in practice.’ On that topic, Richard Jones recalls a corresponding observation of the numerous and diverse public engagement processes pertaining to the subject of nanotechnology: ‘We have learnt that public engagement can deliver some clear messages about the directions that wider society would like technology to evolve towards; what is less clear is the degree to which the recipients of those messages have any agency to act on them’ (Chapter 23). He takes the reader back to the early 2000s in order to draw specific lessons from the case of nanotechnology; at the time, when it was experiencing both unrealistic hype and somewhat science fiction-driven opposition, first commercial examples of the technology that had been coined as a phenomena-based discipline in its own right were entering the market. While some organisations called for a moratorium on all nanotechnology commercialisation and research, other groups strongly supported the application of nanotechnologies in medicine and healthcare, under ‘explicit rejection of an unduly precautionary approach.’ Jones highlights a fundamental problem of the manifold public engagement exercises of the time: ‘In many cases, there is a mismatch between the messages that have been coming from the public and the capacity of the people or organisations to deliver any of the changes that the public desire.’

Moreover, Bernd Carsten Stahl et al. note that the levels of responsibilities themselves (are perceived to) differ between stakeholders (Chapter 24). This has hardly been better illustrated than in the current debates about the manufacture and supply of some of the vaccines that — after an unprecedentedly short period of research and development — have already been authorised for use against COVID-19¹¹: wishing to cater to the millions of people who were eager to receive a vaccination and who were angry about the news that limitations in manufacturing the vaccines would delay the vaccination of most people until the summer, some started calling for the government to revoke the patent for the vaccines so

¹⁰ Responsible Research and Innovation (European Union, Horizon 2020): <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation> (accessed: February 2021).

¹¹ World Health Organisation Emergency Use Listing/Prequalification (WHO EUL/PQ): https://extranet.who.int/pqweb/sites/default/files/documents/Status_COVID_VAX_08Feb2021.pdf (accessed: February 2021).

that ‘everybody’ could start manufacturing them. Such calls to be justified (and in some cases supported) by the lingering biased opinion of the ‘bad reputation that the pharma industry had created for itself’ and addressed to the government as an agency of ultimate responsibility.

How to Successfully Implement R(R)I?

In Chapter 21, Armin Grunwald provides a realistic view of what can be expected from R(R)I in emerging technological practices: he concludes that ‘we should accept [that anticipation is not possible on any sound epistemic ground] and look for a type of orientation beyond consequentialism.’ He claims that hermeneutic analysis should avoid too narrow a focus on future possibilities by providing insights into premises and biases; it should contribute to opening up the field so as to take into account not only anticipations of the current world but also other possible worlds. On a similar topic, Bernd Carsten Stahl et al. conclude that ‘[t]here is no one-size-fits-all model of RRI.’ The authors describe a Delphi study that suggests ‘that there is a broad motivation to consider the societal consequences of a company’s activities but that there is also an awareness of the importance of responsible actions as regards corporate reputation and customer relationships’ (Chapter 24). In other words: ‘Where stakeholder trust is increasingly important, losing that trust can be the death knell of an enterprise’, as noted by Andrew D. Maynard and Elisabeth Garbee in Chapter 32.

Robert Madelin, ex-Director General and Advisor on Innovation (European Commission), in an interview with Jan Staman and René von Schomberg (Chapter 35), believes that ‘we need multiple urgent actions [in support of RRI’s implementation]. We need real people to participate and neither the method nor the procedure is the problem. Political willingness however is, and there is a relationship to risk-taking. Even when citizens show willingness to take risks in innovation, governments do not, for instance, in order to safeguard human rights. An of course, these values have to be considered thoroughly but there should be space for experiments on sense-making and risk-taking, and the way of doing this is by enabling people to participate in the process.’

Governance of Innovation in an Era of Knowledge Democratisation

Under the section title ‘governance’, Miles Brundage and David H. Guston provide a review of the development of R(R)I, juxtaposing the ‘grievances and demands of responsible innovation advocates’ with the ‘resistance to responsible innovation’ by some people (Chapter 7). Through their case study on artificial intelligence and robotics, the co-authors highlight an interesting discussion that is not limited to debates of science and technology: who should be invited to speak at an event that aims to inform and elucidate the issues and arguments around a specific topic. To this, Luc Soete adds reflections on the role of the many who may receive the (pre-selected) information provided by a few experts (Chapter 8), ‘which for centuries had privileged access to scientific facts and wisdom’: he describes the case of an American popular science magazine that, after an attempt to aid the ‘democratisation of knowledge’ by facilitating readers’ comments on their website, decided to bar these again, stating that ‘[c]omments can be bad for science. [...] The problem is when trolls and spambots overwhelm [lively intellectual debates] with vexing comments.’

In Chapter 8, Luc Soete questions, ‘whether the change brought about by new technologies and innovation, always represents the Schumpeterian model of creative destruction, [by which] creative processes [are] likely to renew society’s economic dynamics leading it ultimately to a higher level of economic development, at the cost though of the destruction of a few incumbents with the accompanying employment and skill losses, but to the benefit of many newcomers.’ The author concludes that ‘[s]uch innovation process might well have led our societies to a long-term conspicuous consumption path of innovation-led destructive-creation growth’, but, to me (the author of this review), it seems that the EU’s proposed ‘right to repair’ makes an effort to address this development among other goals.¹² Soete’s discussion of the likely impact of ‘destructive creation’ as the mirror image of that of the

¹² EU’s ‘right to repair’ motion: <https://www.europarl.europa.eu/news/en/press-room/20201120IPR92118/parliament-wants-to-grant-eu-consumers-a-right-to-repair> (accessed: February 2021).

Schumpeterian process of creative destruction, however, is a terrible omen for the fate that befell the service sectors, in particular across the world, as the COVID-19 pandemic struck just a few months after the handbook's publication.

How to Conduct R(R)I When There is No Pandemic?

As a former industry representative who — in line with the concept of ‘shared responsibility’¹³ (an idea that is so similar to that of R(R)I that only morphic resonance could have been at play) — aimed to bring together and collaborate with all stakeholders (and who once got told to ‘finally decide whether one wanted to be an NGO or an industries association’), I find the concept of ‘situations in which we are [often] confronted with innovations that nobody had actually called for or even anticipated’ (Chapter 1) one of the hardest notions of R(R)I to fathom. While there is little to question about the idea of giving priority to the grand challenges of our time¹⁴ and accepting that the COVID-19 outbreak has created an unprecedented example of the latter, thereby serving as a magnifying glass to scrutinise all those aspects of R(R)I that enabled the roll-out of rapid responses to an acute grand challenge in the form of a pandemic, it also becomes very clear that none of these rapid reactions would have been possible without the constant prior support of knowledge generation and infrastructures for science, technology and innovation, or without the ongoing collaboration between universities, industries and governments. And while innovations in pandemic-free times may not be regarded as being as universally useful as life-saving vaccines and treatments, they always contribute to the generation of knowledge, understanding and education, and their commercialisation enables the creation

of skilled jobs and state-of-the-art infrastructures. The questions raised by Doris Schroeder and David Kaplan (Chapter 20) appear to be a particularly good descriptor of my personal problem with the concept of ‘societal desirability [of an innovation]’: ‘[W]ho decides what is of benefit to society as a whole? The market? The government? Powerful interest groups? Even if a more democratic approach were chosen, how would it be implemented?’ In an attempt to answer what constitutes R(R)I, the authors look in detail at the concepts of (a) ethical acceptability, (b) sustainability and (c) societal desirability, and introduce the concept of ‘inclusive innovation’ as an element that provides R(R)I with a global perspective. The authors find it encouraging that an innovation concept driven by powerful emerging economies, such as South Africa, Brazil, India and China, can be aligned with European discussions of RRI. The United Nation Sustainable Development Goals (UN SDGs)¹⁵ and the Paris Agreement¹⁶ are early examples of the need for and feasibility of global R(R)I; nevertheless, it needs to be remembered that the implementation of R(R)I practices requires carefully crafted local activities and measures that are designed in consideration of and strongly embedded in specific local regulatory, socio-economic and cultural contexts.

In the handbook, the global applicability of the R(R)I concept is presented through a detailed description of its interpretation (and implementation) in China (Chapter 28 (Chapter 29)), India (Chapter 30), South-East Europe (Chapter 31), low- and middle-income countries (Chapter 33) and the USA (Chapter 32); the latter discusses the concept of R(R)I with a specific focus on the country's culture of entrepreneurship. The authors find that there are ‘three dimensions that create vulnerabilities where principles of responsibility are not effectively incorporated and acted on in the culture of entrepreneurship: tight coupling, latency, and value mismatch. [...] Without codified approaches to responsibility and innovation, the good intentions of entrepreneurs will in many cases remain good intentions, and no more. This is especially the case within the US culture of entrepreneurialism, where so much power and responsibility are placed on the individual.’

¹³ The Nanotechnology Industries Association (NIA) that I had the honour of introducing as a ‘new player’ to the Brussels lobbying landscape promoted a responsible and sustainable innovation in nanotechnology through (a) a framework of shared principles for the safe, sustainable and socially supportive development and use of nanotechnologies, and (b) a publicly and regulatory supportive environment for the continuing advancement and establishment of nanotechnology innovation: https://en.wikipedia.org/wiki/Nanotechnology_Industries_Association (accessed: February 2021).

¹⁴ Cf. the Lund Declaration: https://era.gv.at/public/documents/57/1lund_declaration_final_version_9_july.pdf (accessed: February 2021).

¹⁵ UN SDGs: <https://sdgs.un.org/> (accessed: February 2021).

¹⁶ Paris Agreement to combat climate change: <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement> (accessed: February 2021).

What Do You Want to be When You Grow Up?

In his discussion in Chapter 23, Richard Jones deliberately utilises the term that some of us were most concerned about when the concept of ‘responsible research and innovation’ was introduced and when nanotechnology inadvertently became the object of its many concept developments and implementation experiments: ‘irresponsibility’ (i.e. the implication that something had been or still was ‘irresponsible’ by virtue of not specifically highlighting its responsible character or characteristics). Naming-controversies, such as this, however, may be understood as side effects of the honourable wish to develop a universal concept so that it evolves to become a global motion by giving it a recognisable, positive name while circumventing specific terms and acronyms that had become irrevocably tinted by historic events; these controversies seem to befall all modern-day ideas from ‘safe-by-design’ to ‘social distancing’. Robert Madelin uses the word irresponsibility to outline the role of policy-makers: he notes that ‘we can design processes for responsibility. Nowadays you will find irresponsible regulation mostly at the access end’ (Chapter 35).

Nearly two decades after the first careful attempts to embed responsibility and reflexivity in the R&I process, Richard Jones concludes that ‘[t]he debates around nanotechnology, public engagement and responsible innovation have been sustained in the UK for more than a decade, so it is natural to ask whether anything substantial in the science policy has actually changed as a result of it. This is a difficult question to answer because the wider science policy landscape itself has been changing so fast.’

As part of the discussion of ‘responsibility and ethics’, Vural Özdemir (Chapter 5) muses about which one of his parents R(R)I will take after as it matures: the author looks at the discipline of bioethics and the history of the emergence of STS during the public debates of the 1960s and 1970s (often but not exclusively touching on or concerned with technological topics such as nuclear energy, weapons developments and tests), the coining of the terms ELSI (ethical, legal and societal issues) and ELSA (ethical, legal and societal aspects), and asks: ‘Will RI gravitate towards the extant in-frame approach of the powerful wing of bioethics, and risk losing its cutting edge to ask hard, critical, on-frame questions? Conversely, will RI bring about a much needed on-frame analysis to the science-enabler wing of bioethics that has dominated science and technology analysis in the neoliberal era? Will RI ask hitherto

neglected questions, such as the opportunity costs of innovation and particular technologies, and weather we should pursue in some cases de-growth in the face of wasteful exhaustion of many planetary resources?’.

All signs appear to indicate that R(R)I is well on its way to becoming a proud pillar of the advancement of science, technology and innovation worldwide, and that it will be able to address all of the abovementioned on-frame challenges by casting an increasingly wide assessment net.

The *International Handbook on Responsible Innovation — a Global Resource* is a formidable witness to this ‘coming of age of responsible innovation (RI)’, as Christopher Coenen puts it in his cover testimonial. However, re-reading this handbook, which harbours such a wealth of knowledge and practical advice for R(R)I practitioners, during the COVID-19 pandemic also shows that all concepts of responsibility and reflexivity are only as good as the objects of its ‘re’-active ideas allow it to be. In that sense, a second and third volume of this excellent handbook should address stakeholders and policy-makers respectively, also with regard to the rapid developments in artificial intelligence research that massively change our societies; as big data analyses treat every individual as if they were a networked data point, it becomes increasingly important that everybody understands their role in modern-day research and innovation and is empowered to decide responsibly about their own actions or inactions within it.¹⁷ Policy-makers, on the other hand, benefit from a global resource handbook on R(R)I as it allows them to better judge the appropriateness of (specific, prescribed) R(R)I measures and to understand their limitations, when driving the development and implementation of R(R)I, not least through requirements connected to R&I funding and market authorisation.

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¹⁷ To come back to the subject of the COVID-19 pandemic: the responsibility of an individual involves understanding or appreciating what a vaccine against a deadly virus contains (and does not contain, for that matter) and deciding freely whether or not to take up the offer of a vaccine against the virus, while being fully aware of the consequences of remaining a deadly risk to others.