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INVITED ARTICLE

Look at Mother Nature on the Run in the 21st Century: Responsibility, Research and Innovation

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Abstract
There is growing interest in a framework for responsible research and innovation within Europe. This paper explores why this has come about and suggests that it is related to a concern with emerging and converging technologies that goes beyond a narrow conception of risk to the environment or to human health. Rather, there is a trepidation arising out of the transformative capacity of modern technologies and their stated aspiration to manipulate the natural world. In this context, the paper poses three central questions about the shape of any framework for responsible research and innovation. First, why is the target that of research and innovation? Secondly, at what scale should the framework operate? Thirdly, what form of governance structure would be best suited to the oversight of research and innovation?

Keywords: Technologies, Responsibility, Innovation, Nanotechnology, Biotechnology, Risk, Regulation, Governance

1. INTRODUCTION

Gravitation, Einstein said, cannot be held responsible for people falling in love.[1] But what precisely is the ambit of scientific responsibility for changes no less profound in the world in which we live? On 16 and 17 May 2011 in Brussels, Belgium, the European Commission, in the form of its Directorate General Research,[2] held a workshop to consider a 'Responsible Research and Innovation Framework for the

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The title of this paper derives from Neil Young's song 'After the Gold Rush' which, in contemporary form, includes the reference to the 21st century. I am grateful to Elen Stokes and Steven Vaughan for their comments on an earlier draft and Felicity Powell for her help in organizing the paper.

1 H. Dukas & B. Hoffmann (eds.), *Einstein: The Human Side* (Princeton University Press, 1981), at p. 56.

2 The administrative branch of the European Commission consists of 40 Directorates General (DGs), which are equivalent to ministries at the national level and service the different policy areas for which the Commission has responsibility, including DG Environment, DG Internal Market, and DG Research: see D. Chalmers, *European Union Law* (2nd edn., Cambridge University Press, 2010), at pp. 57–8.

European Research Area'[3] and announced various soft law initiatives to promote responsible research and innovation (RRI). The tag of RRI is in some ways curious. Has research and innovation been irresponsible to date? And, if so, how? Also, the linking of responsibility to innovation might seem to suggest that innovation is the responsible response to problems, so that activities such as geo-engineering become legitimate in the face of climate change. In contrast, responsibility in the context of sustainable development might lie in foregoing the opportunities allowed to us by innovation. Responsibility will need to allow for a maturity of choice in which some possibilities are closed off as others are opened up.[4]

At least one review of responsibility has been established in the context of a commitment to develop nanotechnology, while looking to minimize adverse effects or unintended consequences of that development.[5] Such approaches have been criticized as deploying responsibility as the 'balancing calculus' between the perceived benefits of innovation and the risks to which it might give rise.[6] This is suggestive of supporting a utilitarian endeavour, whereas more deontological approaches[7] might indicate that there are certain things that we should not do, even though we can.[8] A single framework for both research and innovation may also prove problematic. Research may be seen as advancing knowledge whereas technological innovation is concerned with application, often of different sets of knowledge.[9] It may be difficult to frame responsibilities for research when applications of research findings may be diverse and manifold. So, the idea of RRI is not unproblematic. Nonetheless, the pursuit by the European Union (EU) of a soft law framework for RRI is remarkable and ambitious. In this paper, I wish to explore three central questions relating to this initiative: those of objective (why research and innovation?), scale (why the EU?), and governance (why soft law?)

2. OBJECTIVE

The debate about responsibility in relation to innovation is ignited by the transformative power of science, particularly through converging technologies: the ability

[3] European Commission, 'DG Research Workshop on Responsible Research & Innovation in Europe', 16–17 May 2011, available at: http://ec.europa.eu/research/science-society/document_library/pdf_06/responsible-research-and-innovation-workshop-newsletter_en.pdf.

[4] See R. Williams, *Lost Icons: Reflections on Cultural Bereavement* (T & T Clark, 2000), Ch. 1.

[5] See National Research Council, Committee to Review the National Nanotechnology Initiative, *A Matter of Size: Triennial Review of the National Nanotechnology Initiative* (National Academies Press, 2006), Ch. 4.

[6] M. Kearnes & A. Rip, 'The Emerging Governance Landscape of Nanotechnology', in S. Gammel *et al.* (eds.), *Jenseits von Regulierung: Zum politischen Umgang mit der Nanotechnologie* (AKA Verlag, 2009), pp. 97–121.

[7] Though my colleague, Chris Groves, would argue that both utilitarian and deontological approaches become problematic when obligations to the future are at stake: see C. Groves, 'Future Ethics: Risk, Care and Non-Reciprocal Responsibility' (2009) 5(1) *Journal of Global Ethics*, pp. 17–31.

[8] This might reflect the notion of dignity to complete Brownsword's triangular analysis on modern technologies based on utility, deontology and dignity: see R. Brownsword, *Rights, Regulation and the Technological Revolution* (Oxford University Press, 2008).

[9] C. Lyall and J. Tait, 'Foresight in a Multi-level Governance Structure: Policy Integration and Communication' (2004) 31(1) *Science and Public Policy*, pp. 27–37.

of different systems to join in a common endeavour. There is a 'constellation of modern technologies'[10] (including biotechnologies, nanotechnologies, information, and cognition technologies) that involve the manipulation of both biological and non-biological materials and, thus, blur the borders not only of scientific disciplines but also of what might constitute life – the difference, say, between a brain and a computer. There is something radically different not only in the transformative capacity of such technologies but also in their aspiration. The goals of these technologies include manipulation of atomic matter, of genes, and of the earth's climate. Their remit is sweeping and breathtaking and it relates not only to biomedical interventions at the beginning or end of life, but also to the environment in which, and human conditions[11] under which, we live that life. While nature is inevitably interpreted and technically constructed through science, it is now also shaped by its deliberate intrusion.

Add to this the ubiquity of modern technology and the magnitude of its impact. Nanoscience, for example, does not generate a technology of single application. Rather, the engineering of functioning systems at the nanoscale produces a general purpose, enabling technology capable of countless applications in many different fields. Whereas the regulation of technologies given over to a single purpose might be amenable to regulatory oversight by a single agency, this sort of solution is foreclosed by the pervasive nature of nanotechnologies. Moreover, not only do the technologies set out to modify physical processes but they also do so on an industrial basis. This has led to Krohn and Weyer suggesting that society may be used as a laboratory in instances where, to take their example, the impact of the release of genetically modified organisms (GMOs) into the environment is only finally determined by trying it out. They suggest that, as society at large is exposed to the dangers of scientific error in such circumstances, 'this requires a redistribution of responsibility'.[12]

If we place the emphasis here on responsibility, the notion of RRI is evocative of a concern that modernization or innovation can be morally problematic. It could indicate that doubts about scientific progress are no longer confined to the field of technological application, but are increasingly raised at the stage of research. The call is for ethical choice to become embedded in procedures and processes which attach to the research itself to allow a determination of 'what types of decision may be made, how they may be made, by whom, and with the assistance of what resources'.[13] This represents a move towards the institutionalization of decision-making and is well represented by recent moves of the United Kingdom (UK) Engineering and Physical Sciences Research Council (EPSRC) to demand this type of foresight at the grant

[10] Brownsword, n. 8 above.

[11] Although in an environmental journal I am placing an emphasis on the impact on the natural world, this is not to ignore issues such as privacy, human dignity and autonomy reviewed and seen to be under threat in n. 8 above.

[12] W. Krohn & J. Weyer, 'Society as a Laboratory: Social Risks of Experimental Research' (1994) 21(3) *Science and Public Policy*, pp. 173–83.

[13] B. Jennings, 'Possibilities of Consensus: Toward Democratic Moral Discourse' (1991) 16 *Journal of Medicine and Philosophy*, pp. 447–63, at 452.

application stage as it did with the third nanotechnology grand challenge on climate change.[14] This is a fascinating development since research grant income is generally generated by an appeal to future worth, whereas the EPSRC now demands the completion of a risk register to catalogue potential downsides. This is a seismic shift from earlier science-driven models of innovation. The focus on societal, environmental and economic outcomes of research and development in this context might be seen alongside calls for demonstration of the 'impact' of research undertaken. In other words, the return on the investment in science is open to scrutiny.

It goes beyond this, however, because the concern that generates the call for RRI is a product of our enhanced awareness of the power of modern science, which leads to two strands of thinking: one about risk and the other about responsibility. In relation to risk, we have heeded Beck's caution, first written 25 years ago, about the unregulated, and therefore uncontrolled, development of science and technology.[15] The exponential capacity of scientific research to prise open possibility makes more formal modes of control practically impossible. This capacity, well represented by Moore's Law,[16] also makes it likely that even feasible controls will be resisted in favour of seemingly benign promises or the appeal of possibility. Beck spoke of the changing relationship of 'humankind to itself' and the blurring boundaries between the natural and the man-made under such forces. The notion of 'risk' in risk society is wider then than hazard and becomes, as Giddens has observed, a preoccupation with a diversity of possible futures, which we explore in an effort to normalize and control.[17]

Risk society, understood in this way, is intertwined with the increasing influence of science and technology and its capacity to manufacture risk. No longer an unambiguous source of discovery, scientific research is seen as generating rather than negating uncertainties, the resolution of which cannot be found simply in scientific evidence.[18] Indeed the fear is not, or not only, one of anticipated untoward consequences of innovation but (also) of the unforeseen and unforeseeable consequences. While, then, greater attention is given to the environmental and human health consequences of technological development,[19] given the uncertainty and knowledge shortfalls that are emerging, this development is outstripped by the rapidly growing need for anticipatory

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14 R. Owen & N. Goldberg, 'Responsible Innovation: A Pilot Study with the UK Engineering and Physical Sciences Research Council' (2010) 30(11) *Journal of Risk Analysis*, pp. 1699–707.

15 U. Beck, *Risk Society: Towards a New Modernity* (Sage, 1992) translated from the German original: U. Beck, *Risikogesellschaft: Auf dem Weg in eine andere Moderne* (Suhrkamp, 1986).

16 G.E. Moore, 'Cramming More Components onto Integrated Circuits' (1965) 38(8) *Electronics*, pp. 114–7. Moore predicted that for the immediate future 'the number of transistors incorporated in a chip will approximately double every 24 months', at p. 117.

17 A. Giddens, 'Risk and Responsibility' (1999) 62(1) *Modern Law Review*, pp. 1–10.

18 J.S. Applegate, 'Bridging the Data Gap: Balancing the Supply and Demand for Chemical Information' (2007) 86(7) *Texas Law Review* pp. 1365–407.

19 See the approach of the European Chemicals Agency to Socio Economic Analysis under REACH (Registration, Evaluation and Authorisation of Chemicals, Regulation (EC) No. 1907/2006, [2006] OJ L396/1), which has a strong focus on questions of the protection of the environment and of human health, ranked against the economic consequences of decisions to restrict chemicals but which, in spite of the label, has hardly anything 'socio' in the mechanism: ECHA (2008) 'Guidance on Socio Economic Analysis – Restrictions', European Chemicals Agency, May 2008, available at: http://echa.europa.eu/documents/10162/17233/sea_restrictions_en.pdf.

governance, which includes participatory debate on the sorts of future that innovations may herald. At this point, questions of risk begin to shade into those of responsibility.

Hans Jonas – coming from a different direction from Beck, but also writing in the mid-1980s and in an analysis no less compelling – is concerned with the power of technology to penetrate the boundaries of nature to the point that this generates a responsibility that both correlates with that power and is commensurate with it.[20] In other words, it is the scope of the enterprise in the exercise of this power that shapes the nature of the responsibility. Though not one of Jonas' examples, one might say that if synthetic biology seeks to produce tools to redesign the natural world, then it is this very ambition and aspiration that engender and structure the degree of accountability. This is an extensive – perhaps all-embracing – and, for Jonas, metaphysical responsibility in so far as it extends beyond a single generation or species. For Jonas, the identification of this responsibility is crucial in discriminating between 'legitimate and illegitimate goal settings to our Promethean power'.[21] This suggests a scientific futurology, a 'lengthened foresight', which may lead to self-denial of opportunity, and the preservation of values and traditions at the expense of other potentiality.

We are accustomed to viewing responsibility as a moral foundation of legal relationships between citizens under Kantian influence.[22] The norms that shape our morality rest on the status of individuals, who should be treated as ends and not means. Arguably, placing future generations in jeopardy or depleting resources on which they would otherwise depend may be to treat such generations as a means to satisfy present desires. However, as Groves has pointed out,[23] such moral imperatives become much more difficult to apply where the citizens in question do not live in spatial and temporal proximity to each other. We therefore lose some of the guidance of moral philosophy in seeking to make determinations about what might be considered 'responsible' in relation to future technology. Added to the difficulties of time and space are the limitations on foresight, especially in relation to the unidentified and ambiguous. This is not merely a matter of the limits of scientific knowledge, or the existence of a territory of the yet undiscovered lying outside the boundaries of present scientific understandings. Technologies transport[24] such knowledge[25] into a huge variety of social settings and practices.[26] It is our ignorance and the impossibility of knowing about these that pose the

20 H. Jonas, *The Imperative of Responsibility* (University of Chicago Press, 1984), at p. ix.

21 Ibid.

22 Ibid., at pp. 4–12.

23 Groves, n. 7 above.

24 Heidegger would put it much more strongly than this, arguing that technology does not follow science in the form of an application of scientific knowledge but sets the very agenda and mind-set of modern science through its 'enframing' capacity: see M. Heidegger, *The Question Concerning Technology and Other Essays* (Harper, 1977) (edition in translation).

25 Some would contest this depiction of technology as producing the concrete results of scientific knowledge not least because it seems to assert the neutrality of science: see D. Agazzi, 'From Technique to Technology: The Role of Modern Science' (1998) 4(2) *Philosophy and Technology*, pp. 1–9.

26 R. Sandler, 'Nanotechnology and Social Context' (2007) 27(6) *Bulletin of Science, Technology & Society*, pp. 446–54.

real challenge. This constitutes the reflexive element of modernization[27] and its presence produces a need to act responsibly but in conditions of true uncertainty of eventualities. What then of decision-making in favour of responsible innovation under conditions of ignorance and uncertainty?

One rather obvious point is that if such conditions of contingency pertain, then there can be no guarantee that the responsibility will eliminate the risk. However, if we accept, as suggested by Jonas, that there is a correlation between the power of technology and the responsibility for it, then this does begin to suggest collective responsibility on those seeking to share in the technological offerings. The collectivism is highlighted by Jonas,[28] who offers a moral imperative that stresses the weight of the responsibility. This is that the existence and essence of humankind should never be made a stake in the hazards of action. Shared responsibility suggests an opening up of the decision-making processes beyond expert determination to allow the expression of many voices and values about what sort of world we would have and people we would be.

This section of the paper has suggested that the power and scope of modern technologies infringe upon the natural world in such a way that there is a commensurate responsibility in the deployment of the technology. This is not (only) to do with risk as narrowly defined in terms of hazard, but is more to do with the type of future that we might endow. It has been suggested that RRI can never be truly responsible until full account is taken of the social context in which technologies will operate.[29] If this is so, responsibility needs to be shared widely in processes of upstream engagement and in settings that go beyond expert groups.[30] Beyleveld and Brownsword have depicted a 'community of rights', which engages in a continuously reflective process on the best interpretations of its commitments.[31] Responsibility sharing offers no guarantee of a safe or salubrious future but it may negate extreme opposition to innovation. Meanwhile, the process may enhance anticipatory governance by conferring greater legitimacy. Since the turn of the millennium, there has already been a marked rise in the governance focus on economic and societal outcomes together with a greater preparedness for new technologies. This is explored below, but first it is necessary to consider at what scale such governance might be pursued.

3. SCALE

Science policy has traditionally been a matter for nation states, albeit at times in liaison with international organizations.[32] This pattern is changing. There is much

27 Beck, *Risk Society*, n. 15 above.

28 Jonas, n. 20 above.

29 Sandler, n. 26 above.

30 J. Wilsdon & R. Willis, *See-Through Science: Why Public Engagement Needs to Move Upstream* (DEMOS, 2004).

31 D. Beyleveld and R. Brownsword, 'Proceduralism and Precaution in a Community of Rights' (2006) 19(2) *Ratio Juris* pp. 141–68.

32 P. Laredo & P. Mustar (eds.), 'General Introduction', in *Research and Innovation Policies in the New Global Economy* (Edward Elgar, 2001), pp. 2–4.

more supranational collaboration such as that pursued by the EU Research Framework Programmes. At the same time, significant attention is given to the regenerative capacity of science and technology, creating strong regional interest[33] in the importance of knowledge and knowledge spillover for economic development.[34] Because disruptive technologies break through traditional disciplinary boundaries and call for fresh alliances, they may be seen as opening up opportunities for new clusters of research and development activity. Supranational and regional initiatives may be related: EU science policy stresses the contribution of regions of Europe in mobilizing research and development.[35]

As science policy is expanding beyond and within the realm of the nation state, governance too will follow this trend. Converging technologies can give rise to a range of goods, infrastructure, and even services. The end product of technological development will influence the scale on which it might be regulated. For example, nanoscience has already given rise to a wide variety of products in a range of market sectors. The Woodrow Wilson Institute lists over 1,000 products which it has assessed as employing nanotechnological innovation.[36] These are not necessarily whole products but can include product components such as coatings for cars and clothing. There is strong representation of nanomaterials in the sectors of medicines, cosmetics, (agro)chemicals, and electronics, which were early starters in the field.[37]

The propensity of such products to cross borders, not merely within Europe but on a global basis, poses the greatest challenge for their regulation.[38] In the absence of internationally agreed product standards, which is the present case with nanomaterials, restrictions on market circulation are usually justified by reference to risk assessment (risk, here, being narrowly defined by reference to hazards to human health). The WTO *Biotech Products* dispute[39] suggests that there may be little room for democratic self-determination when it is in seeming conflict with trade liberalization and even less acceptance that scientific risk assessment might be other than a policy or value-neutral process that will produce sound scientific decisions[40] to which we can

33 House of Lords Select Committee on Science and Technology, *Science & the RDAs: SETting the Regional Agenda* (The Stationery Office Ltd, 2003).

34 L. Leydesdorff & M. Meyer, 'The Triple Helix of University-Industry-Government Relations' (2004) 58(2) *Scientometrics*, pp. 191–203.

35 European Commission, 'The Regional Dimension of the European Research Area Communication from the Commission', COM(2001)549 final; but see R. Kaiser & H. Prange, 'Missing the Lisbon Target? Multilevel Innovation and EU Policy Coordination' (2005) 25(2) *Journal of Public Policy*, pp. 241–63.

36 Woodrow Wilson Institute, 'Project on Emerging Nanotechnologies', available at: http://www.nanotechproject.org/inventories/consumer.

37 L. Theodore & R.G. Kunz, *Nanotechnology: Environmental Implications and Solutions* (Wiley-Interscience, 2005).

38 G.H. Reynolds, 'Nanotechnology and Regulatory Policy: Three Futures' (2003) 17 *Harvard Journal of Law and* Technology, pp. 179–209.

39 *European Communities – Measures Affecting the Approval and Marketing of Biotech Products*, WT/DS291 (US), WT/DS292 (Canada), and WT/DS291 (Argentina), Panel Report of 29 Sept. 2006, available at: http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds291_e.htm.

40 D. Winickoff, S. Jasanoff, R. Grove-White, L. Busch & B. Wynne, 'Adjudicating the GM Food Wars: Science, Risk, and Democracy in World Trade Law' (2005) 30(1) *Yale Journal of International Law*, pp. 81–123.

adhere. The world trade battleground for nanotechnology might be mandatory labelling requirements, which are actively being considered by the European Parliament as a means to inform consumers of the presence of nanomaterials, but which may constitute a technical barrier to trade.[41] The EU and the United States (US) are already pursuing divergent policies in relation to consumer labelling,[42] with real practical impact on importers in areas such as cosmetics.[43]

Where technological innovation gives rise to infrastructure, one might anticipate that the location of the infrastructure will determine the point of regulation. For the most part this is so, though the location of that infrastructure may be hotly contested and the development itself might be resisted. However, because of the transboundary impacts of the infrastructure, there may be international agreements on operational issues and potential liabilities. The nuclear sector is a good example of this.[44] Concluding such agreements may be a slow and difficult process, but economic and environmental imperatives can drive agreement forward, as has been the case with carbon capture and storage.[45] Again, the EU provides an illustration of how supranational regulation may manage such development through harmonized processes of environmental impact assessment, even though ongoing supervision may be national or entail devolved responsibility, and even though the process involves continual readjustment of divergent approaches.

Technological innovation may give rise to service provision: cloud computing offers an excellent example of the move from product to service. In the case of cloud computing, the location of the infrastructure on which the service depends may be unknown to the end user though the service provision itself might be expected to be governed by national law. Innovations in biomedicine tend to be delivered as individualized services. In the case of reproductive technologies, national regulation, often driven from an ethical standpoint, might seem almost otiose because of the possibility of what Knoppers and LeBris have labelled 'procreative tourism'.[46] Many states may not regulate for the advance determination of what should be permitted either through inability to reach a moral consensus or through an attachment to

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41 *United States – Certain Country of Origin Labelling (COOL) Requirements*, WT/DS384, Panel Report of 18 Nov. 2011), available at: http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds384_e.htm.

42 R. Falkner, L. Breggin, N. Jaspers, J. Pendergrass & R. Porter, *Consumer Labelling of Nanomaterials in the EU and US: Convergence or Divergence?* EERG Briefing Paper 2009/03, Chatham House, Oct. 2009, available at: http://www.chathamhouse.org/publications/papers/view/109136.

43 Labelling is now required in the EU, see Regulation (EC) No. 1223/2009 on Cosmetic Products [2009] OJ L342/59.

44 See the International Atomic Energy Agency (IAEA) Vienna Convention on Civil Liability for Nuclear Damage, Vienna (Austria), 21 May 1963, in force 12 Nov. 1977, available at: http://www.iaea.org/Publications/Documents/Conventions/liability.html; and the Organization for Economic Co-operation and Development (OECD) Paris Convention on Third Party Liability in the Field of Nuclear Energy, Paris (France), 29 July 1960, in force 1 Apr. 1968, available at http://www.oecd-nea.org/law/nlparis_conv.html.

45 Where the desire to continue to exploit hydrocarbon fuel has led to rapid transitions in the international law framework for sub-seabed storage, see R.G. Lee, 'Sub-seabed Carbon Sequestration: Building the Legal Platform' (2009) 30 *Liverpool Law Review*, pp. 131–46.

46 B. Knoppers & S. LeBris, 'Recent Advances in Medically Assisted Conception: Legal, Ethical and Social Issues' (1991) 17 *American Journal of Law & Medicine*, pp. 329–61, at 333.

unhindered market provision of medical services. Even if one pursued concerted efforts to harmonize or approximate the law of individual states,[47] one might agree on the general principles (such as the inviolability of the human person) only to have such agreement unravel in discussions of what is meant by personhood.[48] Because of this, it has been suggested that procreative tourism forms an effective solution to the regulatory problem as well as one that leaves room for moral pluralism.[49] Note, however, that because of the notion of freedom of services, ethical determinations seemingly resolved at the national level with regard to access to biomedicine may suddenly become subject to scrutiny under supranational law. This happened in the case of Diane Blood,[50] who was allowed to travel to Belgium for assisted conception services, with the unlawfully obtained sperm of her dead husband, when the UK Court of Appeal employed 'the trump of EU law to sweep aside the hand dealt by the UK Parliament'.[51]

Finally, note that some technologies may produce hybrids that are neither purely goods nor services. Biotechnology in relation to GMO crops offers a good example. The seeds are a classic economic good. However, their repeated provision to the farmer, when combined with the instrumental purpose inherent in genetic modification, takes on the form of a service. Moreover, once planted, the resultant crops form part of the landscape and local environment in the manner of an infrastructure project. The *Biotech Products* dispute and its aftermath are instructive.[52] The dispute resulted from a de facto moratorium on processing applications for imports of GMOs into the EU. The moratorium was adopted as a result of Member State resistance to GMOs. But since the European Commission itself had never supported the moratorium but rather condoned it to placate the Member States, it was unable to muster a robust defence when the moratorium was being challenged before a WTO dispute panel – instead, it denied the very existence of a moratorium. It might be thought that the WTO Panel finding against the EU would whip the recalcitrant states into line, instead of which the European Parliament voted in July 2011 to give them greater freedom. Under the European Commission proposal,[53] the European-wide authorization system would

47 As has happened with the Council of Europe (CoE) Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the Application of Biology and Medicine (Oviedo Convention on Human Rights and Biomedicine), Oviedo (Spain), 4 Apr. 1997, in force 1 Dec. 1999, available at: http://conventions.coe.int/Treaty/en/Treaties/Html/164.htm, which to date has received just five ratifications. For the problems, see M. Mori & D. Neri, 'Perils and Deficiencies of the European Convention on Human Rights and Biomedicine' (2001) 26 *Journal of Medicine and Philosophy*, pp. 323–33.

48 For this sort of difficulty see the judgment of the Grand Chamber of the European Court of Human Rights in *A, B, and C* v. *Ireland*, Appl. No. 25579/2005, 16 Dec. 2010, available at: http://www.irishtimes.com/focus/2010/echr/index.pdf.

49 G. Pennings, 'Reproductive Tourism as Moral Pluralism in Motion' (2002) 28 *Journal of Medical Ethics*, pp. 337–41.

50 *R* v. *HFEA*, ex parte *Diane Blood* [1997] 2 All ER 687 (CA).

51 D. Morgan & R.G. Lee, 'In the Name of the Father? Ex parte Blood: Dealing with Novelty and Anomaly' (1997) 60 *Modern Law Review*, pp. 840–56; and see T. Hervey, 'Buy Baby: The European Union and Regulation of Human Reproduction' (1998) 18 *Oxford Journal of Legal Studies*, pp. 207–33.

52 See n. 39 above.

53 European Commission, Proposal for a Regulation amending Directive 2001/18/EC as regards the Possibility for the Member States to Restrict or Prohibit the Cultivation of GMOs in their Territory, COM(2010)375 final, 13 July 2010, available at: http://ec.europa.eu/food/food/biotechnology/docs/proposal_en.pdf.

remain but it would be open to Member States to cite, inter alia, agricultural and environmental effects and their potential socio-economic impact to justify a ban or restriction on GMO cultivation. It will be interesting to see if devolved administrations within Member States will look to exploit such an opportunity (as Wales would wish to do within the UK)[54] in a move that is in line with the growing possibilities of autonomous regions within Europe exercising differing policy choices.[55]

In all of these examples I am trying to demonstrate, from experience, the difficulty of centring the regulation of technologies at any particular scale. Certainly, controls at the level of the nation state look increasingly problematic, though they may serve an important declamatory purpose in terms of what is considered tolerable. Even regulatory attempts at the supranational level, as within the EU, may fall foul of international agreements. Moreover, with some technologies (such as geo-engineering) international agreement could prove vital. At the other end of the scale, more local, bottom-up determinations of the choices offered by science and technology might support sustainable development, yet under the forces of economic liberalization it is unlikely that such choices can fully determine the conditions for markets in goods and services resulting from innovation. However, as the GMO experience shows, the realm of the local cannot be ignored if a market is to develop. All of this suggests that a complex, multilevel governance of science and technology will be required if RRI is to oversee the shift of locally based, single discipline scientific research into global multi-disciplinary technological innovations.[56] The question, according to the European Commission, is not whether to deal with 'challenges posed by new knowledge and its applications', but how to do so.[57]

4. GOVERNANCE

Science and technology have long been subject to regulation. The desire to regulate may be driven by wide-ranging motivations, but these generally concern fears of market failure. One obvious concern is that certain technological innovations might generate externalities, in the form of social or environmental costs that may not be internalized in the pricing of any eventual product generated by the technology. There may be other factors, too, for which the market finds it difficult to account, such as ethical concerns generated by the application of technology. In such instances law may be seen to state the limits of scientific research, though this has been the subject of hostile reactions in the past on the part of the scientific community. One

54 The Welsh Government 'takes the most restrictive stance possible to Genetically Modified (GM) crops that is consistent with European and UK law': see Welsh Government, 'Genetically Modified Organisms', available at: http://wales.gov.uk/topics/environmentcountryside/farmingandcountryside/plantsseedsbiotechnology/geneticallymodifiedorganisms/?lang=en.

55 J. Hunt, 'Devolution and Differentiation: Regional Variation in EU Law' (2010) 30(3) *Legal Studies*, pp. 421–41.

56 D. Jacobs, 'Innovation Policies within the Framework of Internationalization' (1998) 27(7) *Research Policy*, pp. 711–24.

57 European Commission, 'Life Sciences and Biotechnology – A Strategy for Europe', COM (2002) 27 final, 23 Jan. 2002, available at: http://ec.europa.eu/biotechnology/pdf/com2002-27_en.pdf.

example of this hostile reaction might be the reaction to the Warnock proposals in 1984,[58] which sought to place limits and controls on embryology in the UK. Interestingly, the eventual resolution of the perceived need for intervention was a command and control solution. The UK Human Fertilisation and Embryology Act 1990 introduced controls through licensing and gave rise to a regulatory agency, the Human Fertilisation and Embryology Authority (HFEA), which the present government appears to regard as a quango that is no longer affordable. Plans to wind down the HFEA were met with dismay by the same scientific community that had once opposed the very idea of such a body. The HFEA was seen as fulfilling an important role in negotiating the boundaries of embryo research and assisted conception. In a telling comment, two senior gynaecologists suggested that 'when these researchers must deal with a broader range of opinions about whether their research should be done, they are likely to regret the loss of a specialist regulator'.[59]

Sceptics might cite this as an excellent example of regulatory capture in which the body created to regulate grows so close to the regulated sector that it becomes seen as friend and not foe. But this might equally be seen as a success in working down the Ayres and Braithwaite regulatory pyramid,[60] so that formal enforcement has given way to successful, consensual processes of compliance. The winding down of the HFEA will not necessarily bring an end to licensing, but it does suggest that the command and control structures are seen as overly bureaucratic, expensive and burdensome, and that future modes of scientific regulation will take a rather different form. It is worth dwelling on why this might be so.

The turn from regulation to governance involves less top-down government and greater involvement of a wide range of stakeholders to achieve the desired ends, described as a move from 'power over' to granting 'power to' such stakeholders.[61] Such a model might be seen as better able to serve as a platform for more deliberative models of public engagement than have been discussed thus far.[62] Ironically, however, governance arrangements are the product of top-down modifications of the role of government in the late twentieth century whereby, rather than performing a providential, welfarist role, government is seen as a source of social intrusion and economic inefficiency.[63] In their replacement of nation states, market states are seen, in contrast, as enhancing choice, with choice becoming a source of authority in its own right.[64] The danger is, however, that technology can displace true rationality, as well as choices

58 M. Warnock (Chair), *Report of a Committee of Enquiry into Human Fertilisation and Embryology* (Cmnd. 9314, HMSO, 1984).

59 J. Parsons & M. Savvas, 'Why We Shouldn't Abolish the HFEA', *BioNews*, 4 Oct. 2010, available at: http://www.bionews.org.uk/page_71776.asp.

60 I. Ayres & J. Braithwaite, *Responsive Regulation Transcending the Deregulation Debate* (Oxford University Press, 1992).

61 J. Pierre & G.B. Peters, *Governance Politics and the State* (Macmillan, 2000).

62 J. Walls, T. Horlick-Jones, J. Niewöhner & T. O'Riordan, 'The Meta-Governance of Risk and New Technologies: GM Crops and Mobile Telephones' (2005) 8 *Journal of Risk Research*, pp. 635–61.

63 T. Judt, *Reappraisals: Reflections on the Forgotten Twentieth Century* (Heinemann, 2008), at p. 8.

64 P. Bobbitt, *The Shield of Achilles* (Penguin, 2002).

in favour of human rights and dignity, and replace this with techno-regulation that binds individuals to a code from which there is little or no opting out.[65]

Notwithstanding such concerns, there may be few options but to invest in soft law modes of governance for a wide number of reasons. One is simply a matter of regulatory capacity for, as Stokes has observed, 'the greater the role of private actors in the administration of regulatory measures, the lower the costs of acquiring information and reducing information deficits'.[66] A second issue of capacity is that more formal command and control regulation, coming as it does with criminal sanctions, depends on certainty in definition or metrics that may not yet be readily deliverable.[67] Soft law may be a wiser response to complex and diverse problems that are characterized by uncertainty, perhaps preceding hard law responses while leaving room for flexibility and responding to unintended consequences.[68] This is partly because of the mismatch of timescales between innovation and regulation[69] which suggest that, however soft the 'law', it may be preferable to a vacuum pending hard law measures. Vogel has suggested, however, that these private regulatory models must eventually be integrated into and reinforced by regulatory enforcement at an appropriate level.[70]

There may also be a link between governance and scale. For example, the prospect of reaching international agreement in areas such as environmental law would appear to grow ever more difficult as its substance becomes entwined with areas such as development and trade liberalization. Hard choices might be more easily faced with soft law.[71] Soft law instruments in this context may take the form of standard setting rather than treaties. Equally, corporate social responsibility (CSR) may generate voluntary subscriptions to codes of conduct, which might be (for example) local to a firm, nationally or transnationally sector-based, or covering a cross-section of industry within or across national jurisdictions. Supranational regulation may trigger global responses in what Heyvaert has described as a regulatory game of winners and losers;[72] soft law approaches are likely to be less prone to retaliatory action.

There is a relationship too between objective and governance. If deliberative, upstream processes are seen as part of the delivery mechanisms of responsibility,

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65 Brownsword, n. 8 above, at p. 242; and L. Lessig, *Code and Other Laws of Cyberspace* (Basic Books, 1999).

66 E. Stokes, 'Regulating Nanotechnologies: Sizing up the Options' (2009) 29(2) *Legal Studies*, pp. 281–304.

67 L. Frater, E. Stokes, R. Lee & T. Oriola, *An Overview of the Framework of Current Regulation Affecting the Development and Marketing of Nanomaterials* (UK Department of Trade and Industry, 2006).

68 U. Mörth, *Soft Law in Governance and Regulation* (Edward Elgar, 2004).

69 With law 'in the rear and limping a little', see *Mount Isa Mines* v. *Pusey* [1970] 125 CLR 383 (Windeyer J).

70 D. Vogel, 'The Private Regulation of Global Corporate Conduct', in W. Mattli & N. Woods (eds.), *The Politics of Global Regulation* (Princeton University Press, 2009), pp. 151–88; and hard law and soft law ought not to be seen as in opposition but rather can meld into hybrid structures: see V. Heyvaert, 'Levelling Down, Levelling Up, and Governing Across: Three Responses to Hybridization in International Law' (2009) 20(3) *European Journal of International Law*, pp. 647–74.

71 J.J. Kirton & M.J. Trebilcock, 'Introduction: Hard Choices and Soft Law in Sustainable Global Governance', in J.J. Kirton & M.J. Trebilcock (eds.), *Hard Choices, Soft Law: Voluntary Standards in Global Trade, Environment and Social Governance* (Ashgate, 2004), pp. 3–29.

72 V. Heyvaert, 'Globalizing Regulation: Reaching Beyond the Borders of Chemical Safety' (2009) 36(1) *Journal of Law and Society*, pp. 110–28.

these are more likely to give rise to soft law instruments such as codes, voluntary agreements, action plans, resolutions, statements, certification schemes, standards and strategies. Responsibility itself suggests voluntary assumption rather than enforced action – soft rather than hard law approaches. The assumption of shared responsibility commensurate with the aspirations of many converging technologies suggests engagement outside of the democratic sphere of legislative action in more decentralized social settings: the sphere of soft rather than hard law. This is challenging and, to some degree, concerning to those who might fear the displacement of the rule of law by rule of technology.[73]

5. CONCLUSION

Mapping out the contours of a responsible research and innovation framework is likely to be a protracted and problematic assignment. This paper tries to offer an overview of the terrain. It is rugged and somewhat indistinct, yet its silhouette is there. The objective of the framework must be to address broad societal concerns that stretch well beyond simple notions of hazard to include wider contingency and doubts about the very direction of some technologies, stirred by our awareness of their transformative capacities. The framework must be not only participatory but also anticipatory. It cannot be confined to balancing benefit against risk because it must concern itself not just with material wealth but with moral health.

We are all charged with this task, but the questions of the appropriate scale on which to pursue it are complex and the answers may vary in accordance with the innovations engaged. Because we can be sure that there is no single territory in which we can confront the challenges of ordering our technological futures, the exercise will be one of multilevel governance. This is because the task outstrips the remit of governments, certainly individually but probably even when they seek to act in concert. Partly as a consequence, soft law instruments must play a part but we need to ensure that they are the product of the upstream, inclusive engagement that forms the spine of responsibility. Soft law instruments are not in opposition to hard law variants, which may prove necessary with time. Great care must be taken that the use of soft law is institutionalized into research and development practices but that these mechanisms, as a result, do not become subject to capture. 'Soft' cannot mean 'yielding' if we are to leave room to rein in some of the potential of innovation, rather than have it reign over us.

[73] Brownsword, n. 8 above, at pp. 1–6.

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