

<b>Institution:</b> University of Exeter
<b>Unit of Assessment:</b> Business and Management Studies
<b>Title of case study:</b> Responsible Innovation: managing the responsible emergence of science and innovation in society.
<p><b>1. Summary of the impact</b> (indicative maximum 100 words)</p> <p>A Responsible Innovation Framework developed by Prof Owen is transforming how Research Councils and the Technology Strategy Board (TSB) fund and deliver programmes of science and innovation. The Framework recently became a central element of EPSRC's research policy. It has supported key governance decisions by EPSRC concerning the first, contentious UK field trial of climate engineering technology. It was embedded in EPSRC's Delivery Plan and Doctoral Training Centres, and TSB's Synthetic Biology Roadmap, Industrial Feasibility and Innovation and Knowledge Centre programmes. It has been an important input into a restructuring by the European Commission of the European Research Area, underpinning its Horizon 2020 Strategy and Innovation Union.</p>
<p><b>2. Underpinning research</b> (indicative maximum 500 words)</p> <p>Innovation is a powerful, uncertain and unpredictable activity that produces not only social and economic value but ethical dilemmas and impacts that can be global and intergenerational in nature. Innovation is also something that can be managed responsibly. Professor Owen is pioneering research that aims to understand how we can collectively manage innovation responsibly under conditions of ignorance and uncertainty, how we can proceed in a manner that is socially desirable and acceptable, and how responsibilities are perceived and distributed. His practical experience of both the strengths and deficits of regulation as an innovation governance mechanism galvanized him to initiate and research the concept of Responsible Innovation (RI) in 2009 to explore how such deficits could be addressed and the leadership role that may be played by Research Councils, the Technology Strategy Board (TSB) and companies (e.g. in the insurance and finance sectors) involved in funding and undertaking innovation. He has held the Chair in Responsible Innovation at the University of Exeter since 2010, and the research has been supported by two research fellows (ESRC, EPSRC and EU funding) and six PhD students (ongoing).</p> <p>Building on an initial EPSRC pilot grant in 2009-10 which supported research to frame the concept, he led the development of a comprehensive RI Framework in 2011, funded by ESRC and EPSRC, and which was evaluated by ESRC as 'outstanding' in its final evaluation. The research supporting the development and application of this framework has been strongly multidisciplinary in nature, bringing together concepts and methodologies from disciplines of strategic innovation management (a core Business School strength), governance, ethics, and science and technology studies. These underpin a framework based on a set of overarching and integrated dimensions which emphasize that for innovation to be responsible it should be continuously <i>anticipatory</i>, <i>reflexive</i> and inclusively <i>deliberative</i>, continuously opening up innovation to broad reflection on its purposes and future possible impacts (intended or otherwise). Critically, the approach is researching concepts of institutional <i>responsiveness</i>, e.g. governance mechanisms that ensure that the trajectory of innovation is responsive and that reflection is coupled to action. This emphasis on practice has led to a number of implementation experiments at the Research Councils and TSB (e.g. nanotechnologies, synthetic biology), and most recently in financial institutions (e.g. new financial product development department at Fidelity International Asset Management). A further EPSRC grant provided an opportunity to research the framework's application in the contentious field of climate engineering, demonstrating its broad application.</p> <p>These experiments have in turn catalysed organizations to reflect on their own responsibilities, policies and practices and the co-creation and adaptive learning aspects of the research have been key. Research has also occurred at an EU level, reflecting the European Commission's announcement in 2011 that it would be reconfiguring the European Research Area around 'responsible research and innovation', in its Horizon 2020 Strategy, following an expert group</p>

**Impact case study (REF3b)**

meeting in March 2011 attended by Prof Owen. This is being investigated within the climate engineering field as part of EU FP7 grant (EU TRACE), Prof Owen is a co-investigator.

**3. References to the research** (indicative maximum of six references)

The following **publications** describe the underpinning intellectual framework used in the impact case study.

(i) Stilgoe J., Owen R., Macnaghten P.M. (2013) Developing a Framework for Responsible Innovation. *Research Policy* 42 (3) 1568-1580.

(ii) Owen R., Stilgoe J., Macnaghten P.M., Fisher E., Gorman M., Guston D.H (2013). *A Framework for Responsible Innovation*. Chapter 2, in (eds R.Owen., J. Bessant, M.Heintz,) *Responsible Innovation*. John Wiley, London; p.27-50.

(iii) Owen R., Macnaghten P., Stilgoe J. (2012) Responsible Research and Innovation: from Science in Society to Science for Society, with Society. *Science and Public Policy* 39: 751-760.

(iv) Macnaghten P and Owen R (2011) Good governance for geoengineering. *Nature* 479: 293

(v) Owen R (2011) Rising to the Challenge of Responsible Innovation. *Journal of the Parliamentary Scientific Committee* 16(1):5-6 01 Mar 2011.

(vi) Owen R., Goldberg N. (2010) Responsible Innovation: A Pilot Study with the U.K. Engineering and Physical Sciences Research Council Risk Analysis 30(11):1699-1707.

**Research Grants (in ascending chronological order)**

- Owen, R., Pilot Study, Responsible Innovation, EPSRC April 2009 – August 2010 £37,000.
- Owen, R., 'International workshops on Responsible Innovation: Paris, Oslo and Washington with research funders and policy makers'. FCO / French Embassy/ Norwegian Research Council / US National Science Foundation. Funded directly by the French Embassy: £25,000.
- Owen, R., 'Environmental Nanosciences Initiative'. NERC. November 2010 - September 2014, £130,000
- Owen, R., 'Responsible Innovation Framework'. ESRC. June 2011 – February 2012. £54,586.
- Owen, R. & Lenton, T., 'Geoengineering Responsible Innovation' EPSRC. March 2012 – October 2012. £39,883.
- Owen, R. (Co-I) et al., EU TRACE Geoengineering Governance. EU FP7. June 2012 – Sept 2014. EUR 1M.
- PhD funding (5 current PhD students)

**4. Details of the impact** (indicative maximum 750 words)

The impact of this research has been substantive changes in research and innovation policy at the UK Research Councils (notably EPSRC), Technology Strategy Board and European Commission. It has also had impact in key funding and management decisions by these bodies relating to three areas of emerging techno-science and innovation: nanotechnology, synthetic biology and climate (geo) engineering.

The initial impact of the research was at an EPSRC level. Drawing on his experience in establishing and then leading an international science into policy programme in the area of nanotechnologies by NERC and EPSRC, Prof Owen was asked to scope the RCUK 'Nanotechnologies for the Environment' funding call on carbon capture innovation (2009). Prof Owen was granted approval to research, trial and embed some of his early ideas on responsible innovation: this was the first time this had been attempted at EPSRC and the first formal occasion in which researchers applying to EPSRC were asked to reflect on the wider impacts and implications of their research. He introduced a new responsible innovation funding approach in which applicants to the call were required to identify any societal, environmental or other impacts, or ethical concerns associated with their proposed research, qualitatively provide an appraisal of

## Impact case study (REF3b)

risk, and identify responsibilities for managing these risks. Prof Owen worked with EPSRC to develop the peer review and funding panel evaluation procedures for this novel process (see Owen and Goldberg, 2010). This pilot work was an important location to develop the initial framing of the concept and insights into the opportunities and challenges of implementation.

Working with the EPSRC's Societal Issues Panel and Executive, and funded by ESRC and EPSRC, Prof Owen developed the thinking further throughout 2010 and 2011, working closely with EPSRC and ESRC in a co-production mode to develop several key dimensions of responsible innovation (see above). This culminated in a paper to EPSRC Council in October 2012. These dimensions evolved into the development of a generic RI framework and led to a commitment by EPSRC to responsible innovation within its Delivery Plan. It was at this time that EPSRC took ownership of the RI concept, first within their Strategy team. The recommendations of Prof Owen, as noted by the EPSRC CEO for Strategy and Planning, **'had a direct impact and was an integral factor in assisting the advisory group to shape specific recommendations for implementing a responsible innovation approach'**(1). The RI agenda was further developed at EPSRC where, in conjunction with the Director of Impact, Prof Owen led the case for responsible innovation through the strategic advisory structures and Council, **'to develop a responsible innovation framework for implementation across the research council'** (1). The recommendations were formally approved in November 2012 (6) and EPSRC committed fully to RI as a key part of research policy published in September 2013 (6).

In early 2011 the work took on greater significance when Prof Owen was asked by EPSRC, NERC and STFC to use the evolving RI framework to guide decisions concerning the first cross council climate engineering project, underpinning this with a responsible innovation approach. He was asked to develop several responsible innovation criteria, which were used by RCUK to support a decision on the undertaking of the first climate engineering field under the SPICE (Stratospheric Particle Injection for Climate Engineering) project; **'the adoption of the framework ensured a very careful and thoughtful consideration of potential public perception by the research team'**(2); it was critical for EPSRC as the major funder that they proceed, and be seen to proceed, in a responsible manner. This was an important case study to put the conceptual thinking into action: Prof Owen led on embedding the responsible innovation dimensions within an innovation stage gating process drawn from business studies to serve as a governance mechanism, which was used in a pivotal 'stage gate review' panel convened by RCUK with the SPICE team in June 2011. This challenging case study demonstrated the impact and value of the responsible innovation concept in a real world situation **'..after consultation with stakeholders.....the SPICE project team decided not to carry out an experimental component of their project. This decision was made in part as a response to their reviews carried out under the responsible innovation framework'**(2). This project culminated in a publication in Nature that received considerable media attention in the national press (e.g. The Guardian), and extended interviews as part of the BBC programme 'Material World' and the Canadian Broadcasting Company's flagship current affairs programme 'The Current'.

In October 2012 the impact of the RI framework extended beyond the research councils to the Technology Strategy Board and Nuffield Council for Bioethics. The TSB lead for Synthetic Biology states **'the Responsible Innovation framework has been very valuable in helping shape the thinking within Technology Strategy Board as we evolve our position and expectations of project partners to demonstrate they are undertaking responsible practice'** (3). The framework was used as a key input into the drafting of the UK Synthetic Biology Roadmap (4) and **'within the business-led Synthetic Biology Industrial Feasibility competition (2012) and EPSRC-BBSRC-TSB Innovation and Knowledge Centre (2013).....responsible innovation was an important underpinning theme and a key criterion for funding'** (3). These included specific responsible innovation criteria evaluated by a multi-disciplinary 'responsible innovation framework panel' on which Prof Owen sat.

The international impact of the work began in March 2011, when Prof Owen was invited to attend an expert group meeting at DG Research, European Commission, to frame and scope a Responsible Research and Innovation policy initiative. The policy lead for the EC DG Research &

Innovation notes ***'the responsible innovation framework developed by Prof Owen and colleagues has been an important input in terms of the intellectual thinking behind and framing of RRI and has had significant impact at an EU research and innovation policy level in this regard'***(5). This initial meeting was followed by a major international workshop on responsible innovation at the French Embassy in London in May 2011 organised by Prof Owen in which the EC announced its intention to commit to the responsible innovation concept under its forthcoming Horizon 2020 and Innovation Union Strategies (see Owen et al, 2012 above). A series of knowledge transfer activities (workshops, seminars, training) then followed with international research councils, including the Norwegian Research Council in November 2011 and US National Science Foundation in 2012, in part funded by the Foreign and Commonwealth Office. The EU Commissioner for Research and Innovation made a formal policy announcement to reconfigure the European Research Area underpinned by the concept of 'Responsible Innovation' in May 2013, placing the responsible innovation concept at the centre of science and innovation policy in Europe. The significance of this for EC policy is noted; ***'Prof Owen's research has been an important contribution to the development of RRI in terms of both concept and practice, and this has had significant impact in terms of the formulation and development of emerging research and innovation policy at an EU level'*** (5).

#### 5. Sources to corroborate the impact (indicative maximum of 10 references)

**EPSRC. CEO Strategy and Planning.** *Letter corroborating nature and resultant impact of research outcomes.*

**EPSRC. Portfolio Manager – Geoengineering.** *Letter confirming use of Responsible Innovation Framework to guide decisions concerning geoengineering programme.*

**Technology Strategy Board (TSB) - Lead for Synthetic Biology.** *Letter corroborating TSB's use of the Responsible Innovation Framework .*

**TSB UK Synthetic Biology Roadmap:** responsible innovation is a key pillar (theme 2 and specifically page 30) <http://www.rcuk.ac.uk/documents/publications/SyntheticBiologyRoadmap.pdf>

**European Commission - Policy lead DG Research and Innovation.** Supporting Statement corroborating impact of engagement with Prof Owen's RI Framework and resultant implementation.

**EPSRC - Framework for Responsible Innovation** – crediting Prof Richard Owen, Dr Jack Stilgoe (UEBS Research Fellow on Prof Owen's RI grant) and Prof Phil Macnaghten.  
<http://www.epsrc.ac.uk/research/framework/Pages/acknowledgementsandresources.aspx>

**Embedding of responsible innovation framework within EPSRC Centres for Doctoral Training call:** <http://www.epsrc.ac.uk/SiteCollectionDocuments/Calls/2013/CDTcallfinal.pdf> (p.17).

**Technology Strategy Board Responsible Innovation Framework**  
[http://webarchive.nationalarchives.gov.uk/20130221185318/www.innovateuk.org/\\_assets/responsible\\_innovation.pdf](http://webarchive.nationalarchives.gov.uk/20130221185318/www.innovateuk.org/_assets/responsible_innovation.pdf)

**Statement from EU Commissioner** on embedding Responsible Innovation as a policy in EU Horizon 2020 programme: [http://ec.europa.eu/commission\\_2010-2014/geoghegan-quinn/headlines/speeches/2012/documents/20120423-dialogue-conference-speech\\_en.pdf](http://ec.europa.eu/commission_2010-2014/geoghegan-quinn/headlines/speeches/2012/documents/20120423-dialogue-conference-speech_en.pdf)

**EC Directorate-General for Research and Innovation:** *Options for Strengthening Responsible Research and Innovation: report of the Expert Group of the state of art in Europe on Responsible Research and Innovation.*

(Prof Owen's Research Fellow Dr Jack Stilgoe member of Expert Group)

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