Responsible research and innovation and the role of universities

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WAGENINGEN UR
For quality of life

Responsible (research and) innovation: what is it?

- (How) can we steer the development of science and technology so that it meets widely shared societal goals?
- An old idea – but set within a new science and innovation policy context

Defining Responsible Innovation

"Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)"

(von Schomberg, 2011)

"taking care of the future through collective stewardship of science and innovation in the present"

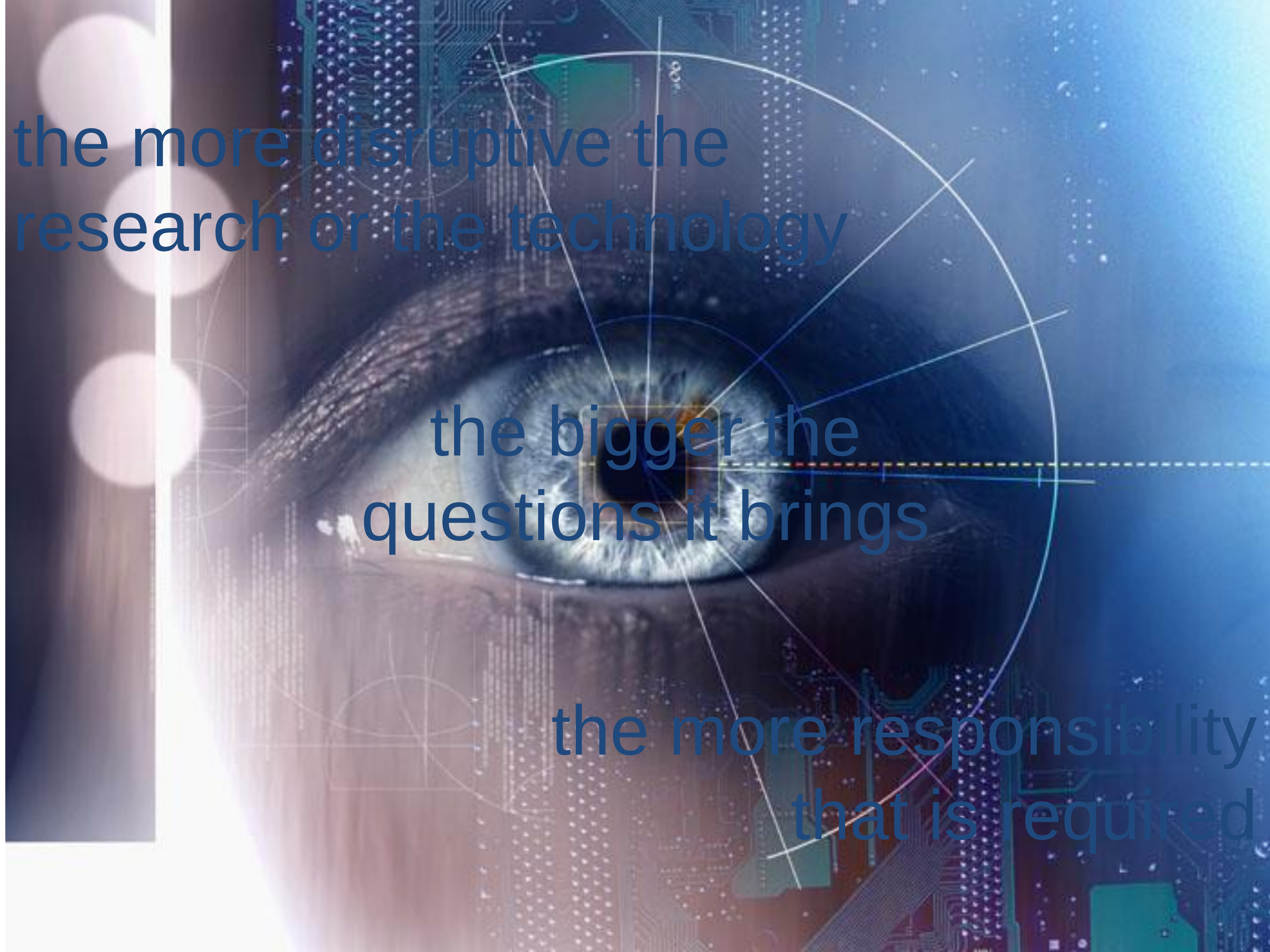
(Stilgoe, Owen and Macnaghten 2012)

Modernist dream of emancipation through science

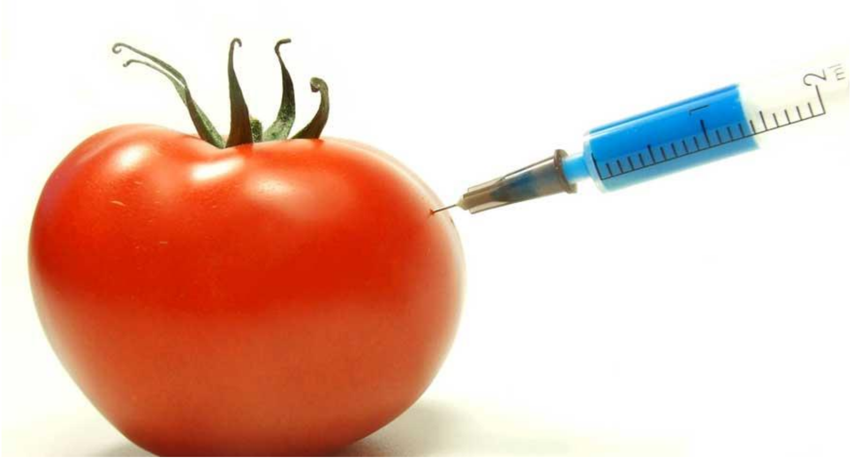
Nature
The past
Contingency
Emotion
Subjectivity

The dream of emancipation?

What about the unexpected consequences?


the more disruptive the
research or the technology
the bigger the
questions it brings
the more responsibility
that is required

Agricultural biotechnologies



"This book wisely shifts our attention from the disputed technical properties of GM crops to the kinds of politics needed. If one book could prod the GM debate out of its current sterile stalemate, then this would be it."
Sheila Jasanoff, Professor of Science and Technology Studies, Harvard University

"Through the subtle studies in this book, GM crops become nothing less than a powerful and poignant metaphor for whatever it is that has replaced the ruthless innocence of modernity."
Daniel Sarewitz, Professor of Science and Society at Arizona State University

"This fascinating and unique book shows that GM agriculture is neither inevitably a good thing nor a bad thing: it depends on the social, ecological and political circumstances."
Jules Pretty OBE, Deputy Vice-Chancellor at the University of Essex

"An alternative pluralistic and inclusive model for decision making on GM crops – a model that just might move us toward better governance of technological change."
Lawrence Busch, University Distinguished Professor at Michigan State University

Although GM crops are seen by their advocates as a key component of the future of world agriculture and as part of the solution for world poverty and hunger, their uptake has not been smooth nor universal: they have been marred by controversy and all too commonly their regulation has been challenged as inadequate, even biased. This book aims to understand these dynamics, examining the impacts of GM crops in diverse geopolitical contexts and their potentials to contribute to sustainable agricultural futures. Part I draws on research from three global 'rising powers' – Brazil, India and Mexico – exploring the views of scientists, farmers and publics. Part II follows with a series of reflective commentary pieces from 11 leading academics in the social and life sciences, developing novel thinking on how to develop a governance framework for the responsible innovation of agricultural GM technologies.

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Environment / Sustainability

an **informa** business
ISBN 978-1-138-89182-1
9 781138 891821

Cover image: ©

Routledge
Taylor & Francis Group
www.routledge.com

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GOVERNING AGRICULTURAL SUSTAINABILITY

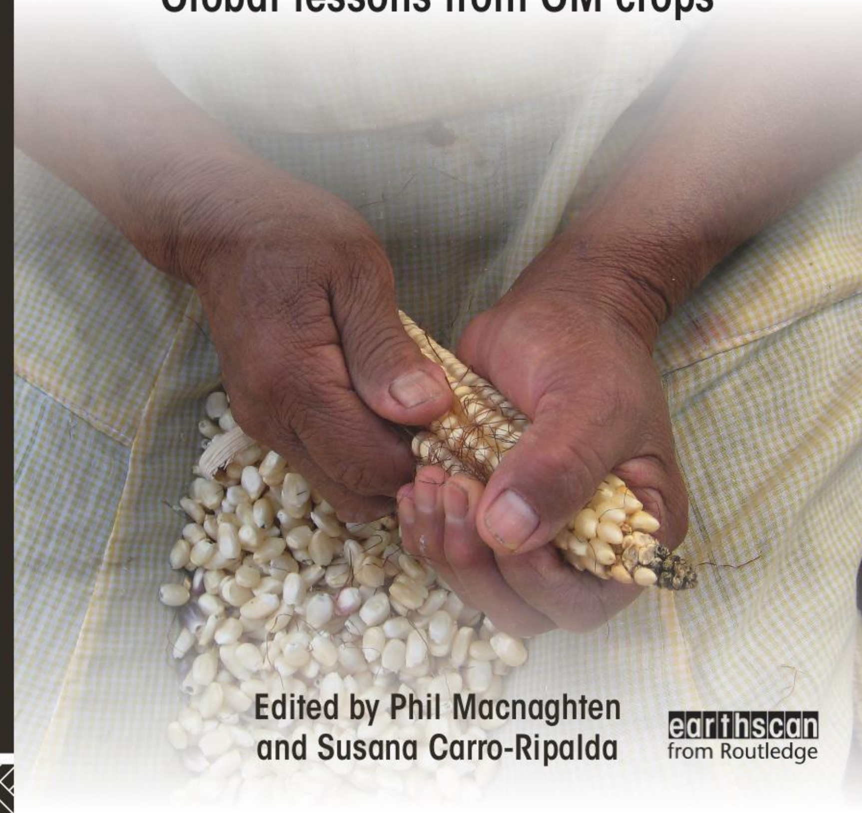
Edited by Phil Macnaghten and Susana Carro-Ripalda

ROUTLEDGE

PATHWAYS TO SUSTAINABILITY

GOVERNING AGRICULTURAL SUSTAINABILITY

Global lessons from GM crops



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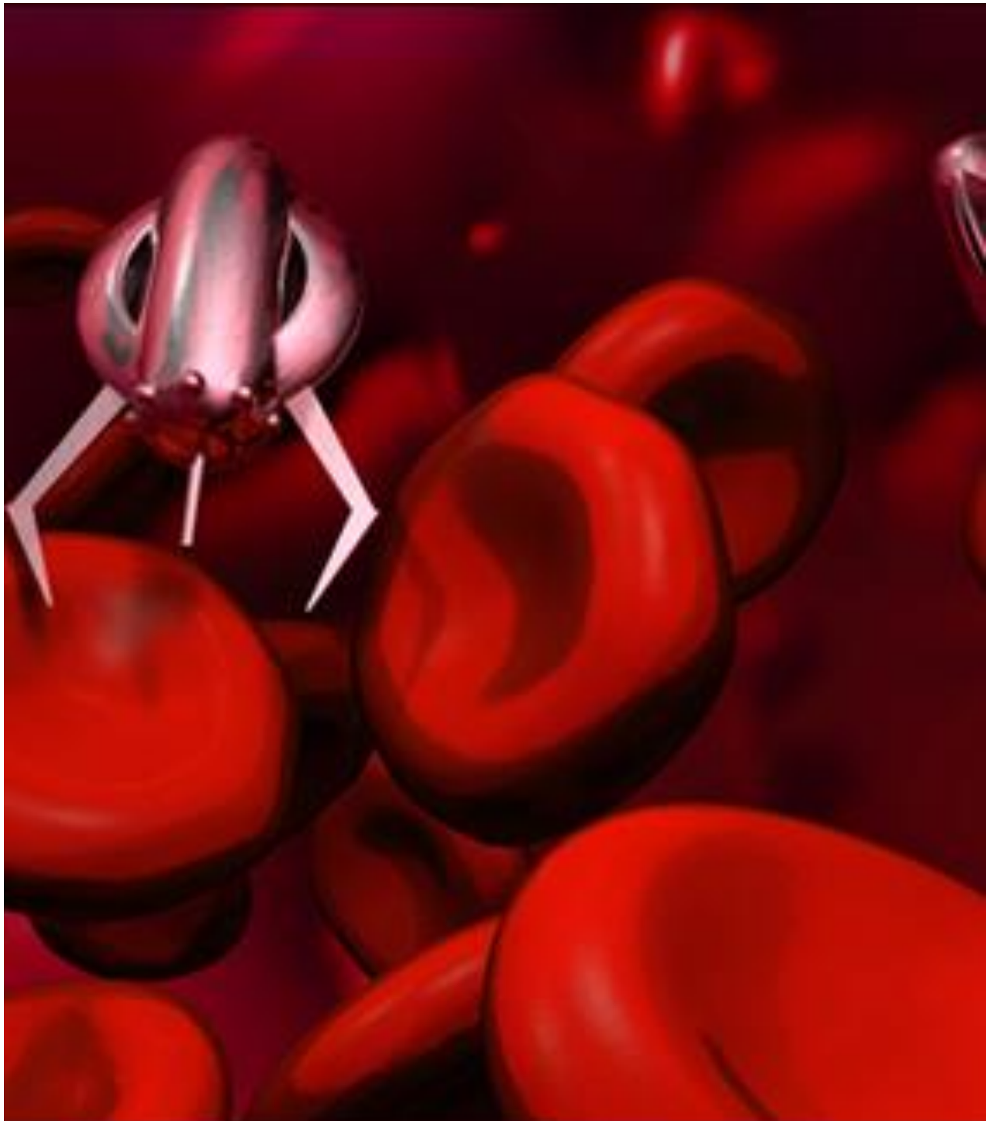
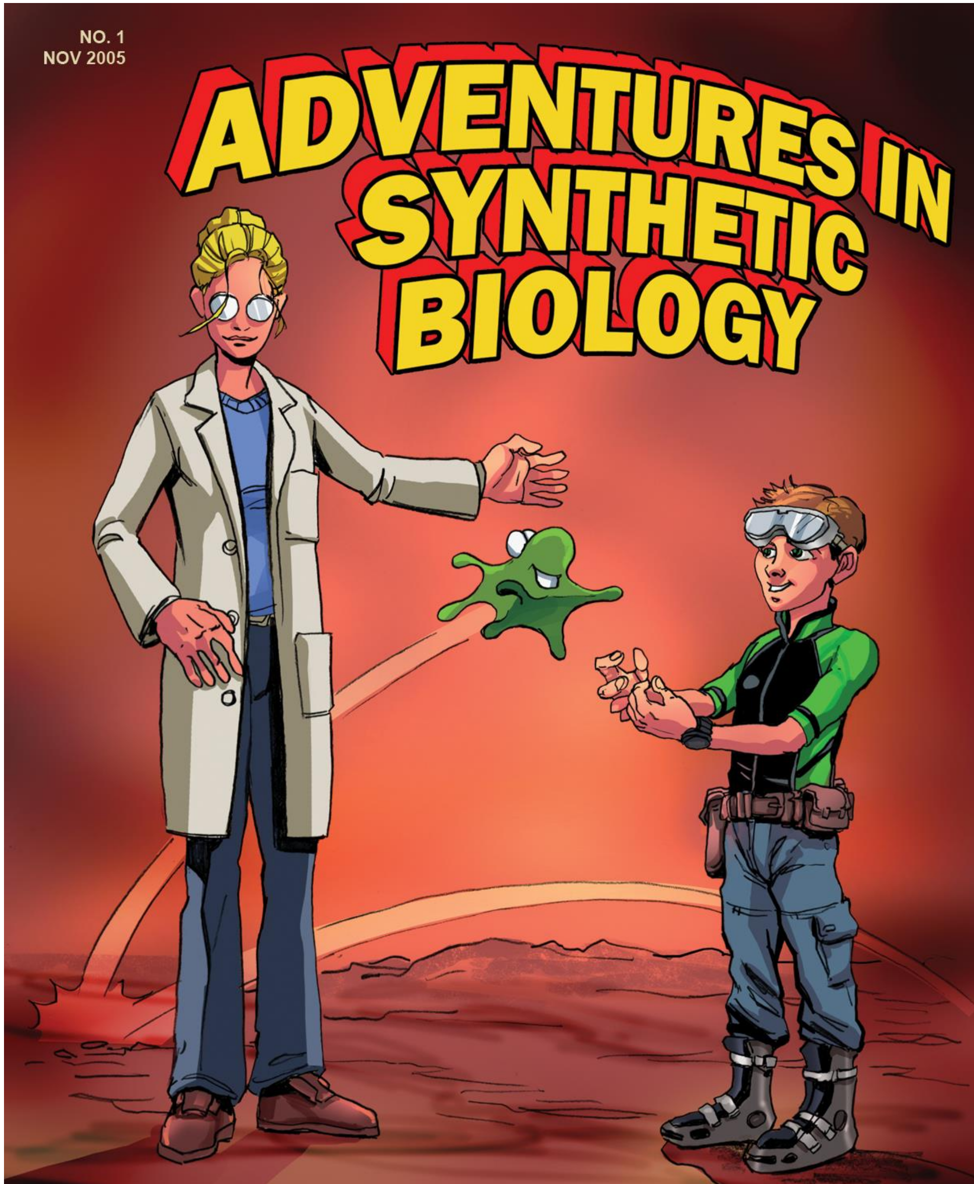
Nanotechnologies

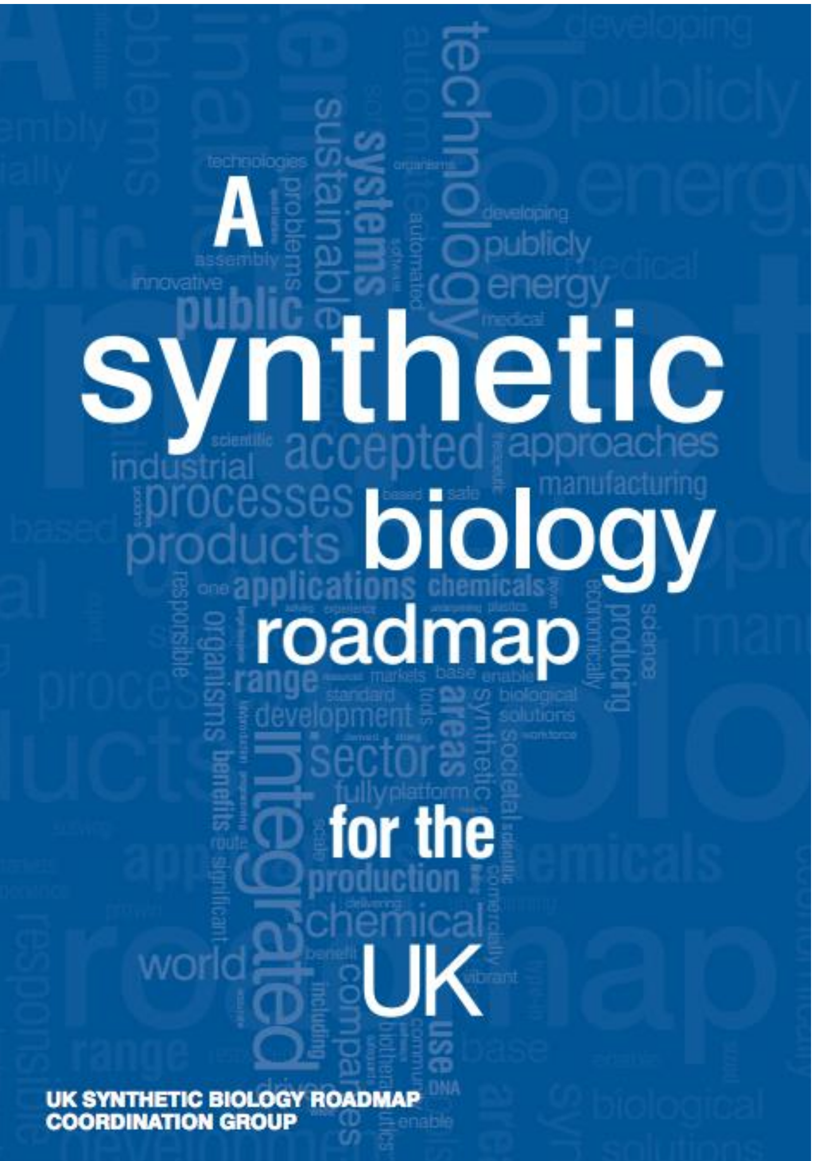


Reconfiguring Responsibility

Deepening Debate on Nanotechnology

Synthetic biology





Theme 2:
Continuing responsible research and innovation

It is crucial that this technology continues to be developed in a socially responsible fashion, and that relevant stakeholders, regulators and the public are engaged in research and innovation processes from the outset. Responsible research and innovation encompasses, but is not confined to, operating within an effective risk regulatory framework. The UK needs to be, and to be seen to be, leading the way in frameworks and methodologies for responsible innovation. The UK has already initiated public dialogue in synthetic biology and encouraged interaction between regulators and funders.

Since synthetic biology is a new field, there is much uncertainty surrounding both the risks and benefits of its research and applications. While stringent risk management is crucial for responsible research and innovation, inescapable uncertainty must be acknowledged and accounted for. The aim of responsible research and innovation is not simply to predict and proactively manage negative outcomes, but also to shape decision-making procedures that recognise such uncertainty across the whole life cycle of innovation. To foster successful innovation, governance must be flexible, transparent, open to wider participation, and responsive to emerging evidence and changing social priorities.

Public acceptability

Public acceptability is widely recognised as a crucial issue for synthetic biology, but it cannot be adequately dealt with through communication aimed at reassuring the public. Prior public controversies on emerging technologies demonstrate that it is essential for debates to go beyond the community of experts to open up discussions about the purpose of innovation and about uncertainties and complexities surrounding both the benefits and risks associated with particular applications. Research has shown that 'the public' is not a singular pre-existing mass that accepts or rejects particular technologies according to fixed preconceptions. The direction taken by innovation pathways, and their perceived social consequences, themselves shape public responses. The responses and decisions of many and varied social groups – alongside those of academic researchers and firms – help to determine technological pathways and the realisation of benefits. These include institutions involved in health, safety and environmental regulation, intellectual property, research funding, and capital investment, as well as intended users and beneficiaries, and civil society groups. New social groups also emerge alongside innovation (new pressure groups may come into being when, for example, a new drug is developed to extend the life of patients with a specific terminal cancer). All of these groups need to be actively engaged, throughout the process, in the governance of synthetic biology research and innovation.

In the UK, public acceptability was recognised as crucial from an early stage and led to a large-scale synthetic biology dialogue in 2010. Findings from the dialogue showed there was support for synthetic biology but that this was conditional. While there was great enthusiasm for the possibilities of the science and its application, there were also fears of control and misuse and concerns about how to govern this novel area when there is uncertainty over its outcomes. One of the key findings of the dialogue – which is consistent with a large body of social science research – was the emergence of these five key questions that synthetic biologists should be willing and able to answer[17]:

- **what is the purpose?**
- **why do you want to do it?**
- **what are you going to gain from it?**
- **what else is it going to do?**
- **how do you know you are right?**

To build on this successful dialogue, it is crucial that these questions are at the forefront of ongoing decisions about the commercialisation, translation and regulation of synthetic biology. Indeed, BBSRC, on behalf of the UK research councils, posed these questions in the closing session of the Six-Academy Synthetic Biology Symposium II in Shanghai in October 2011[18]. Although addressing health, environmental and security risks is important, this will not in itself lead to broad public acceptability unless innovation in synthetic biology is demonstrably directed towards:

- **new products, processes and services** that can bring clear public benefits including, but not limited to, employment, improved quality of life and economic growth
- **solutions to compelling problems that** are more effective, safer and/or cheaper than existing (or alternative) solutions.

Integrating social sciences, humanities and arts researchers can help with understanding of, and engagement with, such issues and thus foster responsible innovation. The UK is at the forefront of experimenting with such cross-domain collaborations: the seven synthetic biology networks included social scientists, artists, philosophers, and legal scholars; and the Imperial College Centre for Synthetic Biology and Innovation (CSynBI) was set up as a joint centre between scientists and engineers at Imperial College and social scientists at the BIOS research group[19].

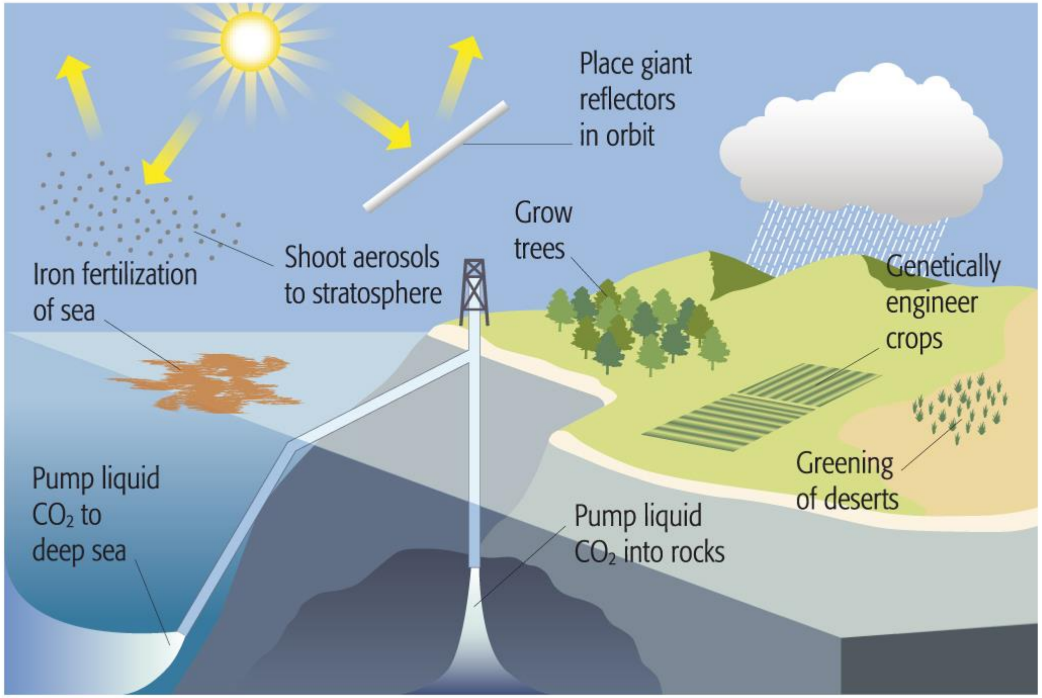
17 BBSRC/EPSRC (2010) Synthetic Biology Dialogue. Swindon. Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC), p.7. Online at: www.bbsrc.ac.uk/web/FILES/Reviews/1006-synthetic-biology-dialogue.pdf
For a summary of how these same issues recur throughout all the ScienceWise Dialogues, see Chilvers, J and Macnaghten, P. (2011) *The Future of Science Governance: A review of public concerns, governance and institutional response*. London: Sciencewise-ERC. Online at www.sciencewise-erc.org.uk

18 Six Academies Synthetic Biology Symposium II – Shanghai 12 – 14 October 2011, www.sibs.ac.cn/synbio/programme.asp

19 BIOS – a centre for Biological Sciences originally based at the London School of Economics (LSE) and now based in King's College London

Climate engineering

GEOENGINEERING SOLUTIONS TO CLIMATE CHANGE

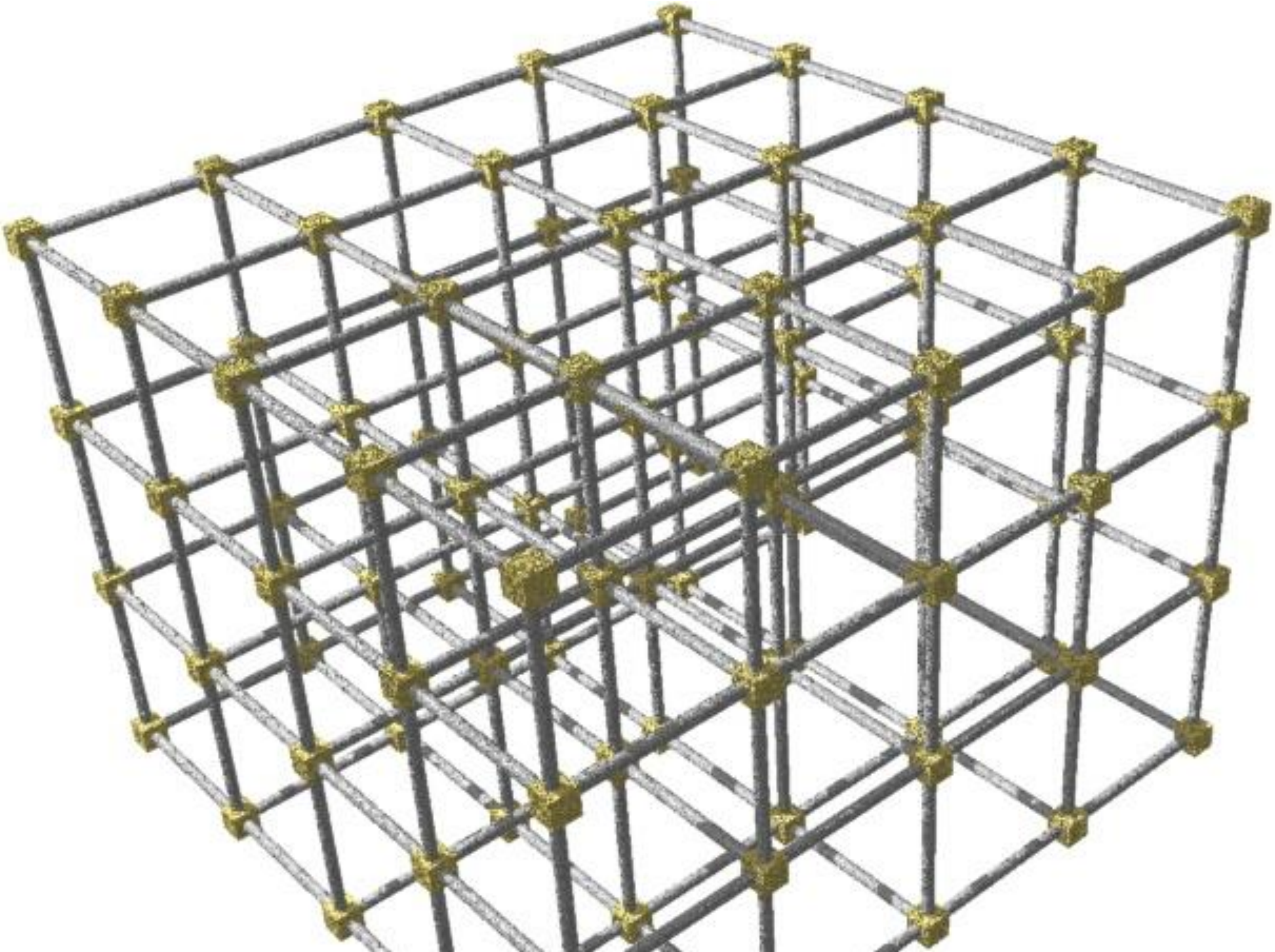


1. What is ‘responsible innovation’ – and what is different about it?

2. Why is it important – and why now?

3. What could it involve – and what is the role of Research Councils?

How to build a framework for responsible science governance

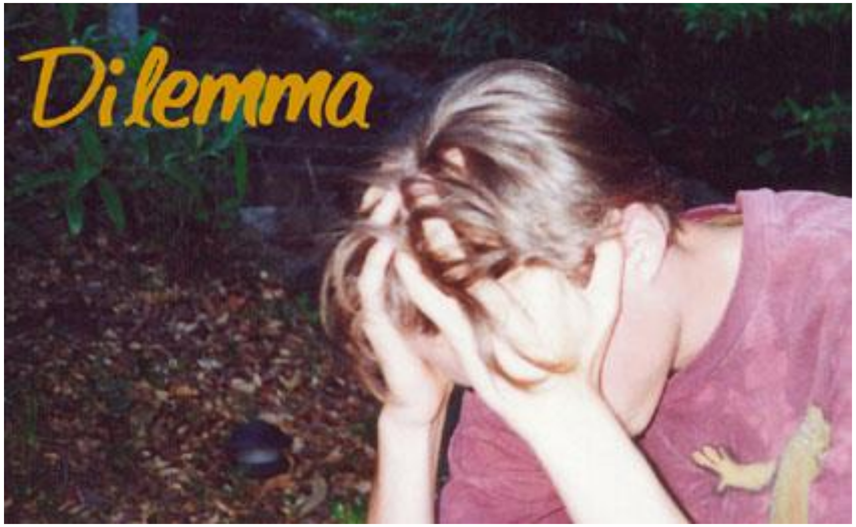


1

Collingridge's control dilemma

When a technology is young enough to influence its future trajectory, you can't know where it will lead

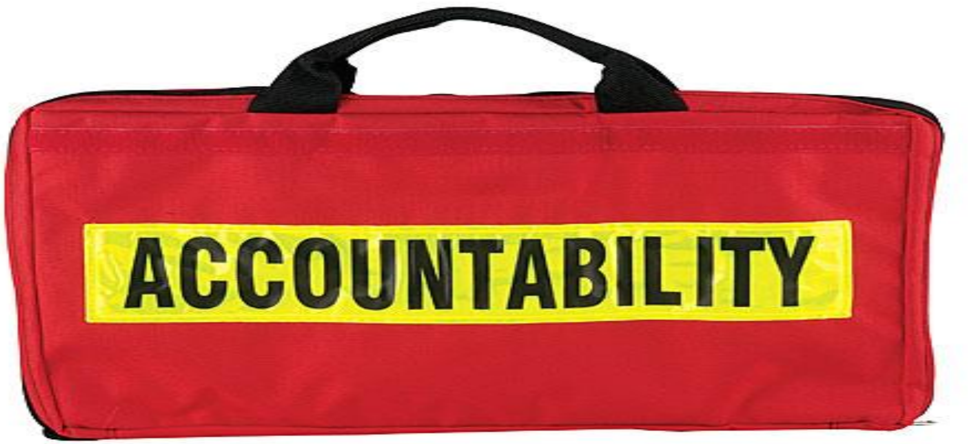
When a technology is mature enough for you to have a good idea of its consequences, it's too late to change it – it's *locked-in*




FUTURE

Responsibility

RESPONSIVENESS



care®

Reconfiguring responsibility

- From retrospective… (*accountability* and *liability)*
- … to prospective (*care* and *responsiveness)*
- … and collective
- Reconfiguring role responsibilities and general responsibilities
- Second-order (or meta-)responsibilities

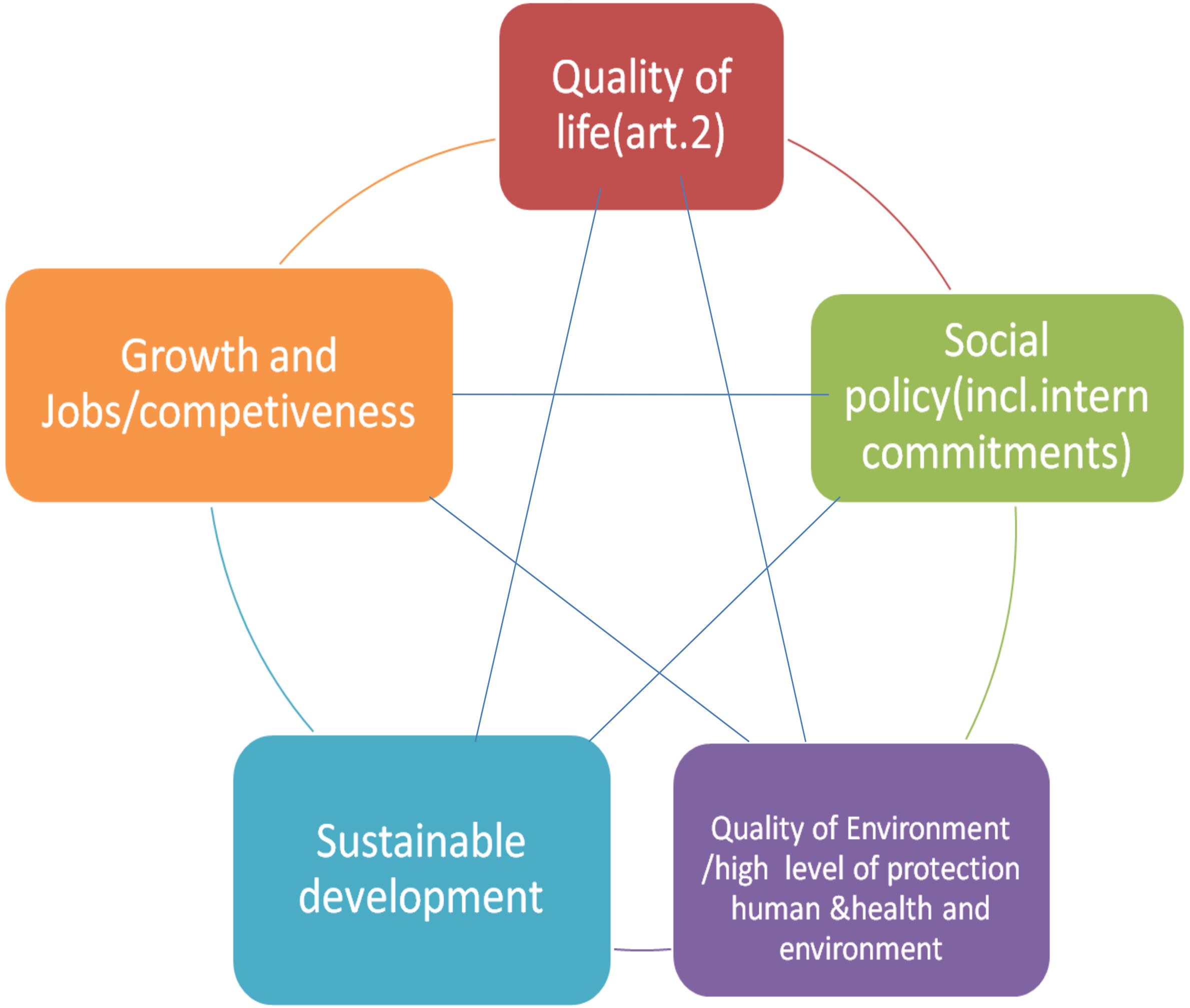
2


Where Are We
Going?

Response 1: to define the 'right impacts' of science

'We can't make an appeal to conceptions of the good life, but we can make an appeal to the normative targets in the Treaty on the European Union. These have been democratically agreed upon and provide the legitimate basis for having a public framework programme for research at the European Level'
(Rene von Schomberg 2011)

Figure 1. Normative anchor point derived from the Treaty on the European Union



Legitimate basis for defining the “right” impacts of research and innovation


THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION
HORIZON 2020

EU2020
Innovation & sustainable growth:
embedded safety and emerging risk management for a competitive Europe addressing the EU Grand Challenges

EU Grand Challenges

+

Embedded safety

Emerging risk management

➡

Safe Innovation

Sustainable growth

Smart growth
Innovation / education

Sustainable growth
climate/energy/ mobility competitiveness

Inclusive
poverty

Five pillars (or keys) of responsible innovation

1. Societal engagement
2. Gender equality
3. Open access
4. Science education
5. Ethics

and

6. Governance

Our alternative approach:

Responsible innovation needs to respond to kinds of questions that publics typically ask of scientists and innovators, or would like to see scientists ask of themselves

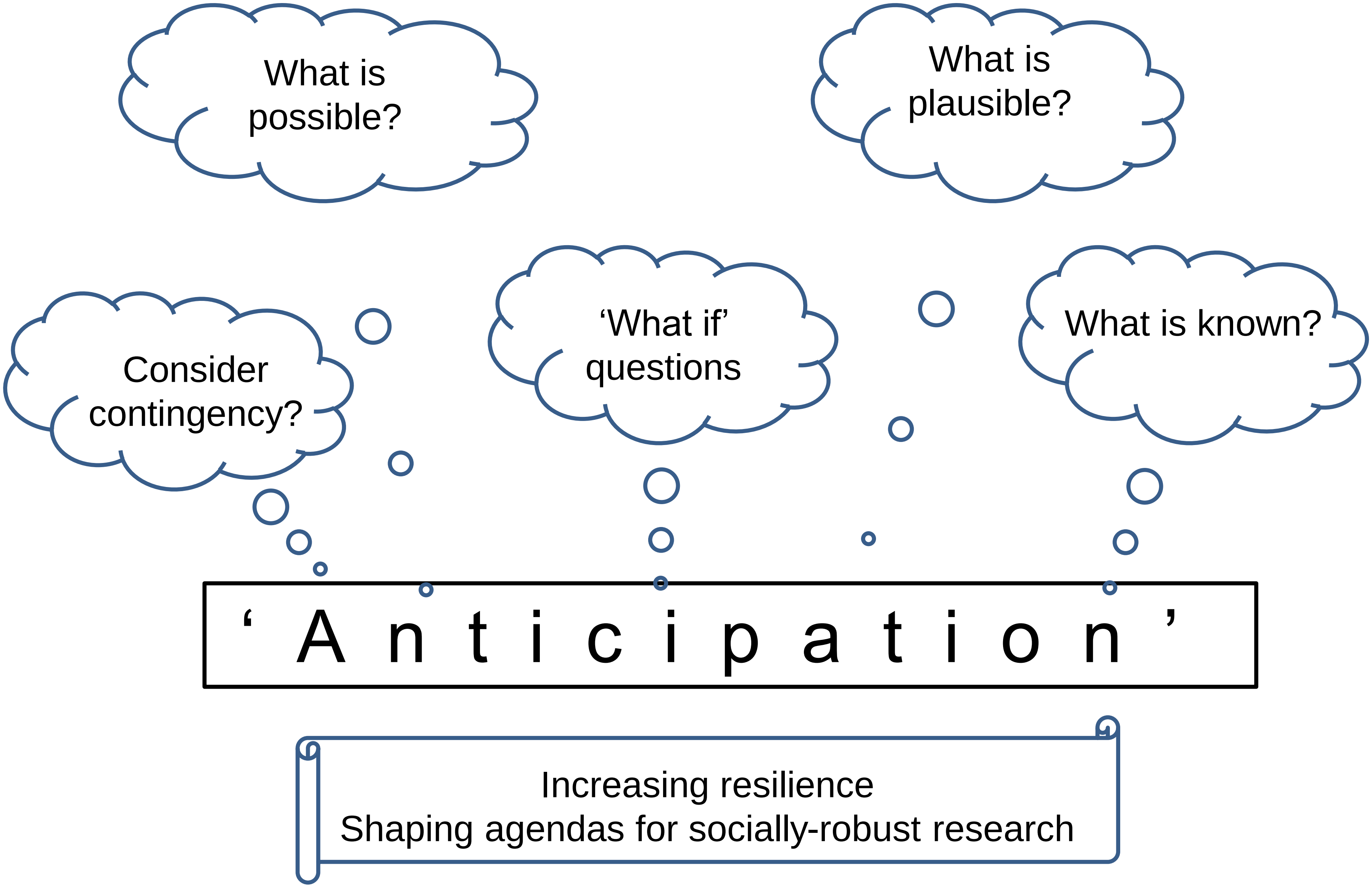
a. Purposes
b. Trust
c. Inclusion
d. Speed and direction
e. Ethics and trade-offs

Lines of questioning on responsibility

Product questions	*Process questions*	*Purpose questions*
What are the likely risks and benefits ?	How should research and innovation take place?	Why should this research be undertaken?
How will the risks and benefits be distributed ?	How should standards be drawn up and applied?	Why are researchers doing it?
What other impacts can we anticipate?	How should risks and benefits be defined and measured?	Are these motivations transparent and in the public interest?
How might these change in the future?	Who is in control?	Who will benefit?
What don't we know about?	Who is taking part?	What are they going to gain?
What might we never know about?	Who will take responsibility if things go wrong?	What are the alternatives?
	How do we know we are right?	

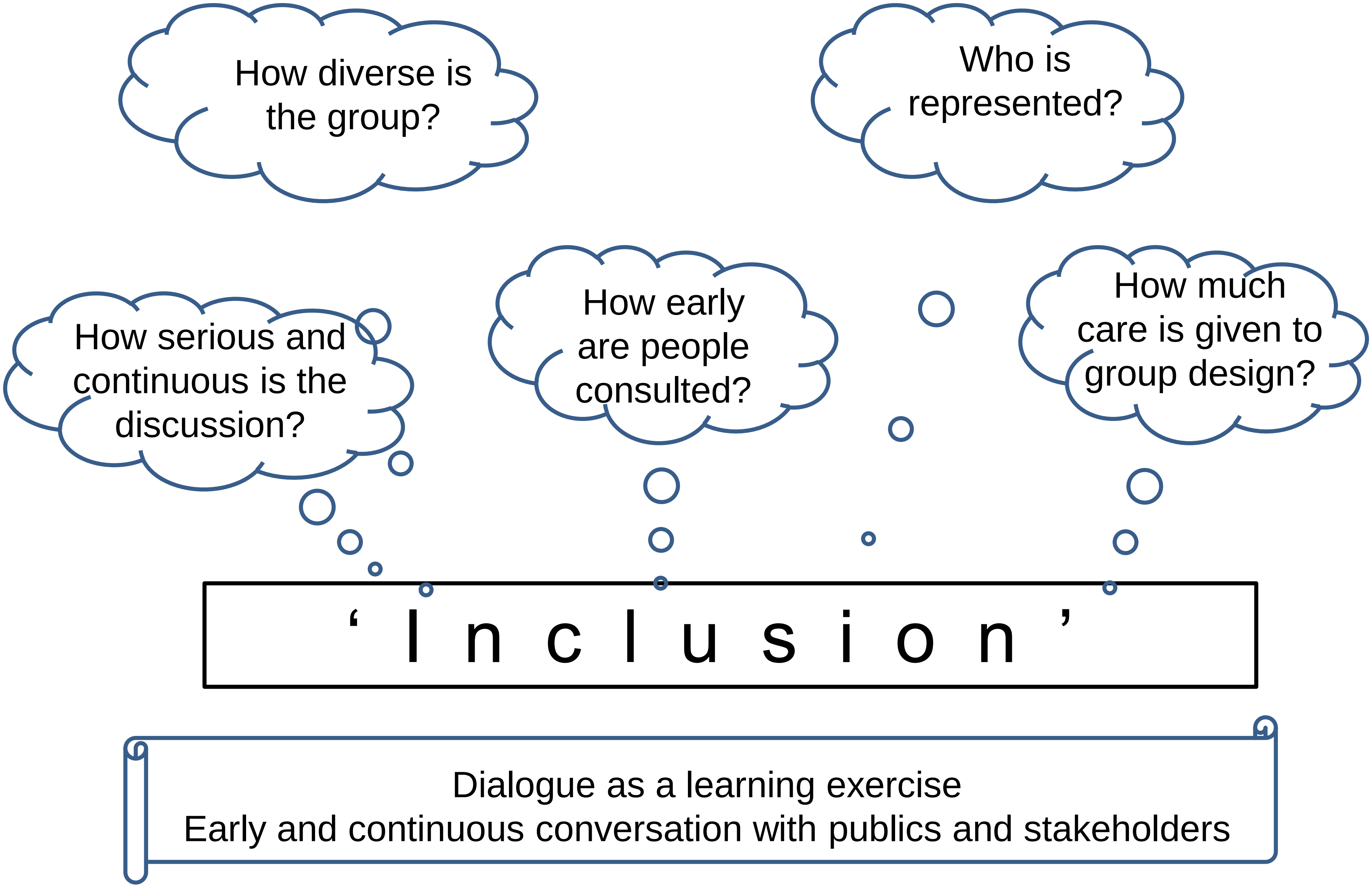

Anticipation
• From predictive to participatory
• Expectations and Imaginaries
• Tools
• Anticipatory Governance
• Vision assessment
• Scenarios
• Barriers to anticipation
• Guston, 2012; van Lente, 1993;
• Fortun, 2005; Barben et al, 2008
Inclusion
• The ‘new’ scientific governance
• Dialogue and ‘mini-publics’
• The challenge of legitimacy
• Input and outputs
• Wilsdon and Willis, 2004; Grove-White et al, 1997;
• Goodin and Dryzek, 2006; Irwin et al, 2013;
• Lovbrand et al 2011
Responsible innovation
Reflexivity
• From 1st to 2nd order
• Tools
• Codes of conduct
• Midstream Modulation
• Wynne, 1993; Schuurbiers, 2011;
• Swiestra, 2009; Fisher et al, 2006
Responsiveness
• Answering and reacting
• Diversity and resilience
• Value-sensitive design
• De facto governance
• Political economy of innovation
• Responsibility as metagovernance
• Pellizoni, 2004; Collingridge, 1980; Friedman,
• 1996; Stirling, 2007; Kearnes and Rip, 2009

Anticipation!

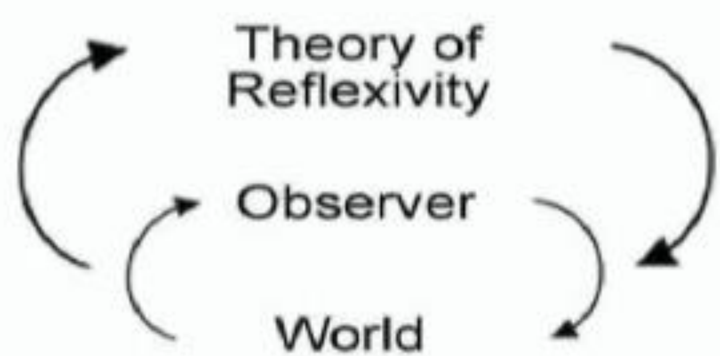

What is possible?
What is plausible?
Consider contingency?
'What if' questions
What is known?
'Anticipation'
Increasing resilience
Shaping agendas for socially-robust research

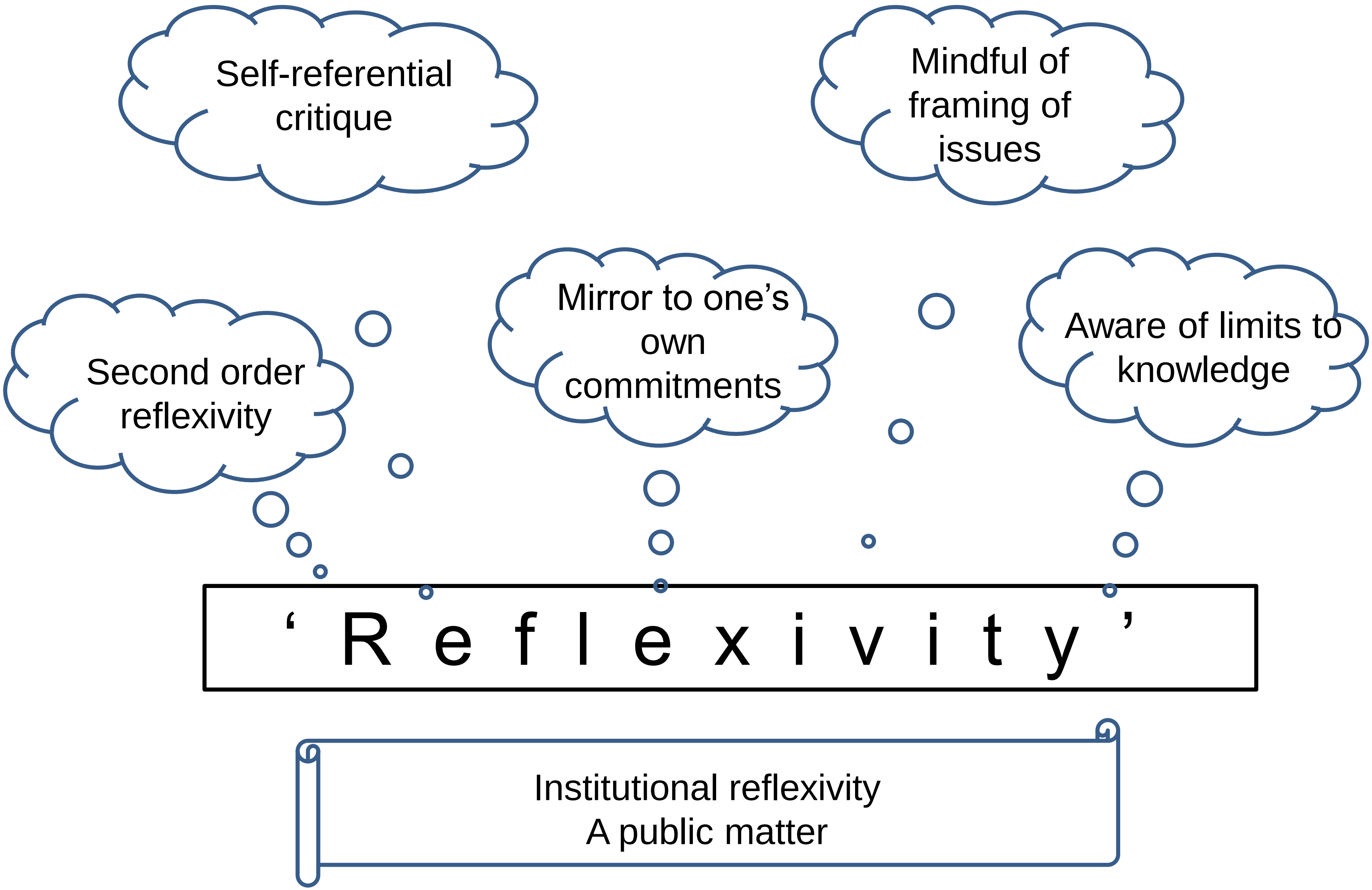
Dimension	Indicative techniques and approaches	Factors affecting implementation
Anticipation	Foresight	Engaging with existing imaginaries
	Technology assessment	Participation rather than prediction
	Horizon scanning	Plausibility
	Scenarios	Investment in scenario-building
	Vision assessment	Scientific autonomy and reluctance to anticipate
	Socio-literary techniques	


inclusion


How diverse is the group?
Who is represented?
How serious and continuous is the discussion?
How early are people consulted?
How much care is given to group design?
'Inclusion'
Dialogue as a learning exercise
Early and continuous conversation with publics and stakeholders

Dimension	Indicative techniques and approaches	Factors affecting implementation
Inclusion	Consensus conferences Citizens' juries and panels Focus groups Science shops Deliberative mapping Deliberative polling Lay membership of expert bodies User-centred design Open innovation	Questionable legitimacy of deliberative exercises Need for clarity about, purposes of and motivation for dialogue Deliberation on framing assumptions Ability to consider power imbalances Ability to interrogate the social and ethical stakes associated with new science and technology Quality of dialogue as a learning exercise

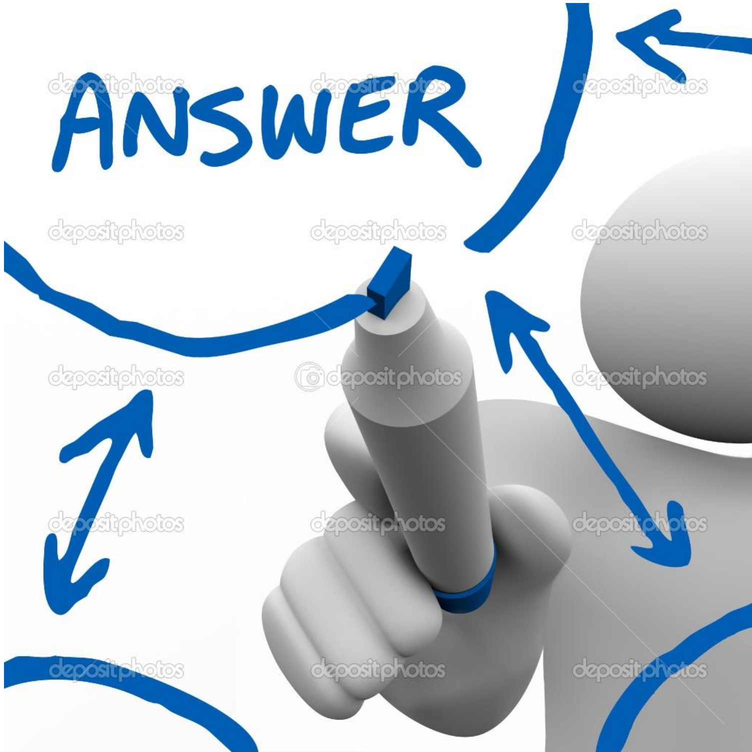

Theory of
Reflexivity
Observer
World

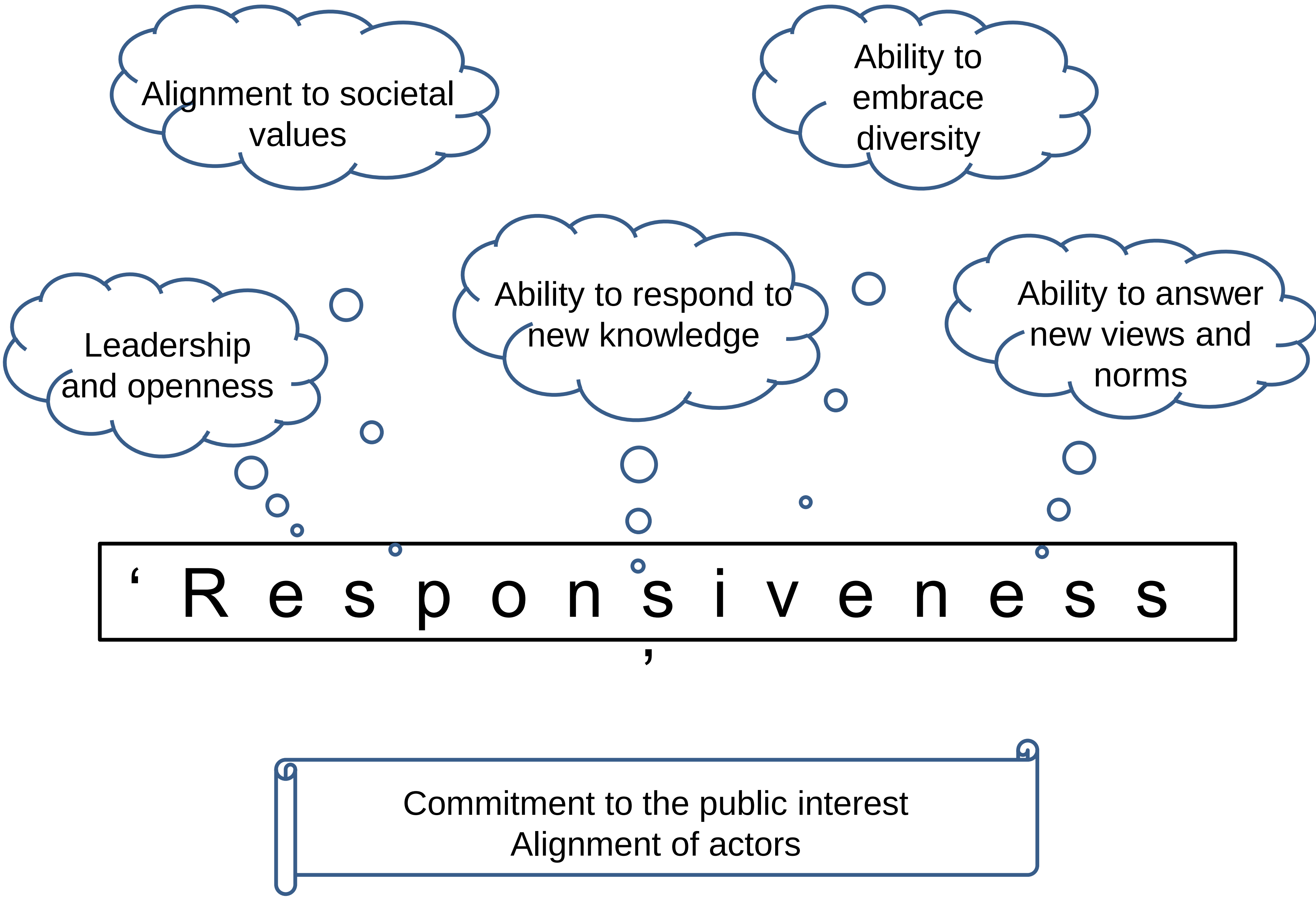

Self-referential critique
Mindful of framing of issues
Second order reflexivity
Mirror to one's own commitments
Aware of limits to knowledge
'Reflexivity'
Institutional reflexivity
A public matter

Dimension	Indicative techniques and approaches	Factors affecting implementation
Reflexivity	Multidisciplinary collaboration and training Embedded social scientists and ethicists in laboratories Ethical technology assessment Codes of conduct Moratoriums	Rethinking moral division of labour Enlarging or redefining role responsibilities Reflexive capacity among scientists and within institutions Connections made between research practice and governance

RESPONSIVENESS

react




Alignment to societal values
Ability to embrace diversity
Ability to respond to new knowledge
Leadership and openness
Ability to answer new views and norms
'Responsiveness'
Commitment to the public interest
Alignment of actors

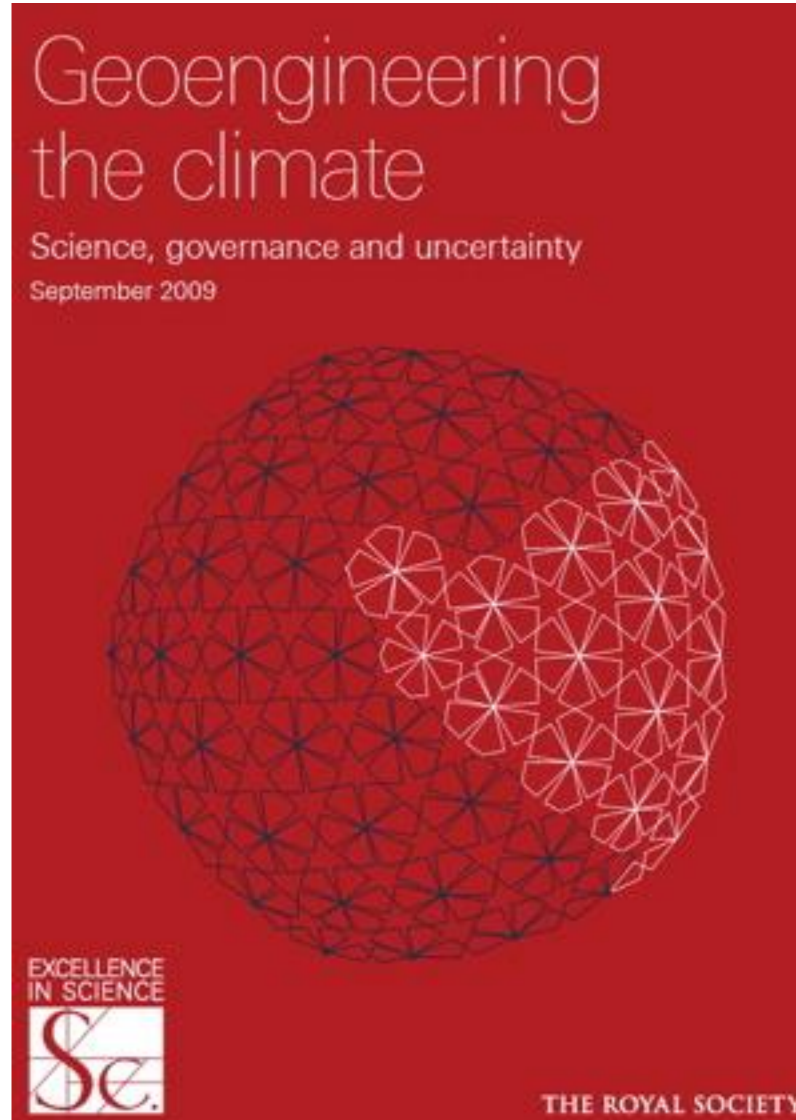
Dimension	Indicative techniques and approaches	Factors affecting implementation
Responsiveness	Constitution of grand challenges and thematic research programmes	Strategic policies and technology 'roadmaps'
	Regulation	Science-policy culture
	Standards	Institutional structures
	Open access and other mechanisms of transparency	Institutional cultures
		Institutional leadership
	Niche management	Openness and transparency
	Value-sensitive design	Intellectual property regimes
	Provision of information	Technological standards
	Labelling	
	Moratoriums	
	Stage-gates	
	Alternative intellectual property regimes	
	New institutional structures and norms	

Responsible innovation in action

Climate Engineering

"Most nations now recognise the need to shift to a low-carbon economy…. But if such reductions achieve too little, too late, there will surely be pressure to consider a 'plan B' – to seek ways to counteract the climatic effects of greenhouse gas emissions by 'geoengineering'."
Lord Rees: foreword

Key recommendations (Research)
Relevant UK government departments (DECC and DEFRA) in association with the UK Research Councils (BBSRC, ESRC, EPSRC, and NERC) should together fund a 10 year geoengineering research programme at a level of the order of £10M per annum.



Climate Engineering:
CO_2 removal & Solar Radiation Management Approaches

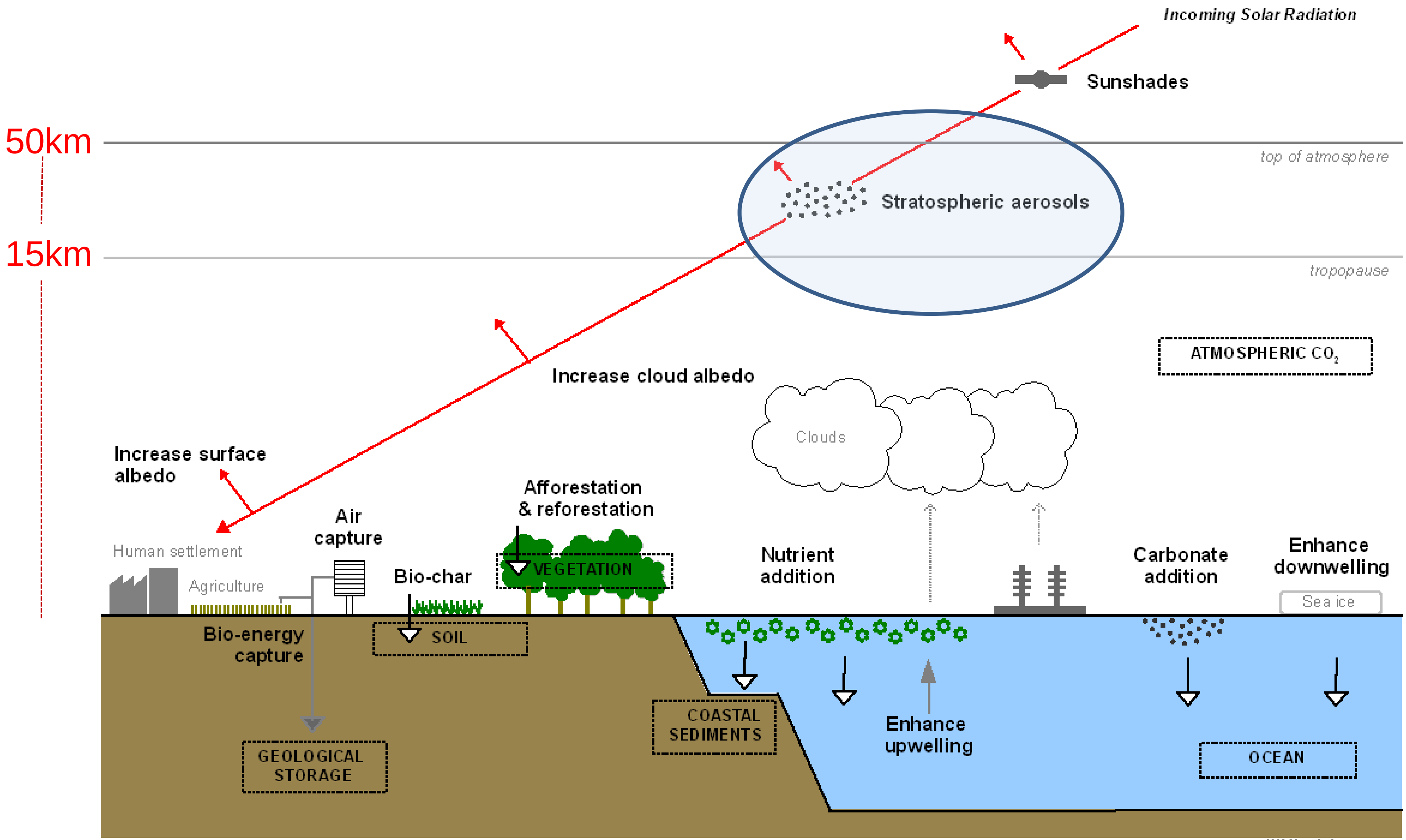


Fig courtesy of Nem Vaughan & Tim Lenton

SPICE project: **S**tratospheric **P**article **I**njection for **C**limate **E**ngineering

EPSRC, NERC, STFC funding

Objective: to investigate the effectiveness of reflecting heat & light back into space using stratospheric particles.

Evaluating candidate particles: what would be an ‘ideal’ particle to inject into the stratosphere (maximizing solar radiation scattering while having minimal impact on climate, weather, ecosystems and human health).

Delivery Systems: feasibility and design of using a tethered-balloon to inject particles into the stratosphere. Use data from **the 1km high test-bed project** in computer models to investigate how a full-scale system might work at an altitude of 20km.

Climate and environmental modelling:
what can be learned from past volcanic eruptions. Also modelling the potential impact on ozone layer concentrations, regional precipitation changes and atmospheric chemistry.

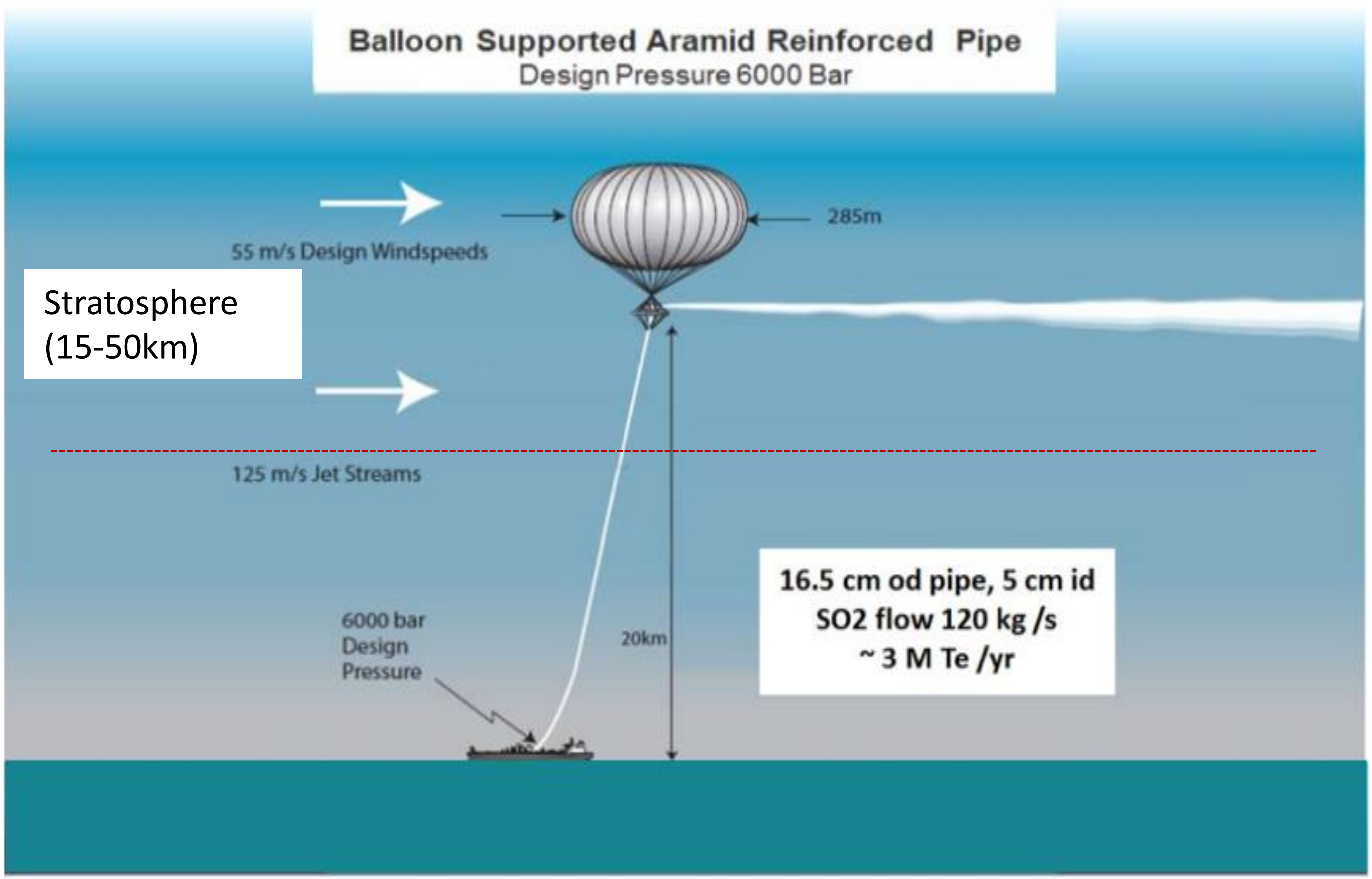


Fig courtesy of SPICE project team

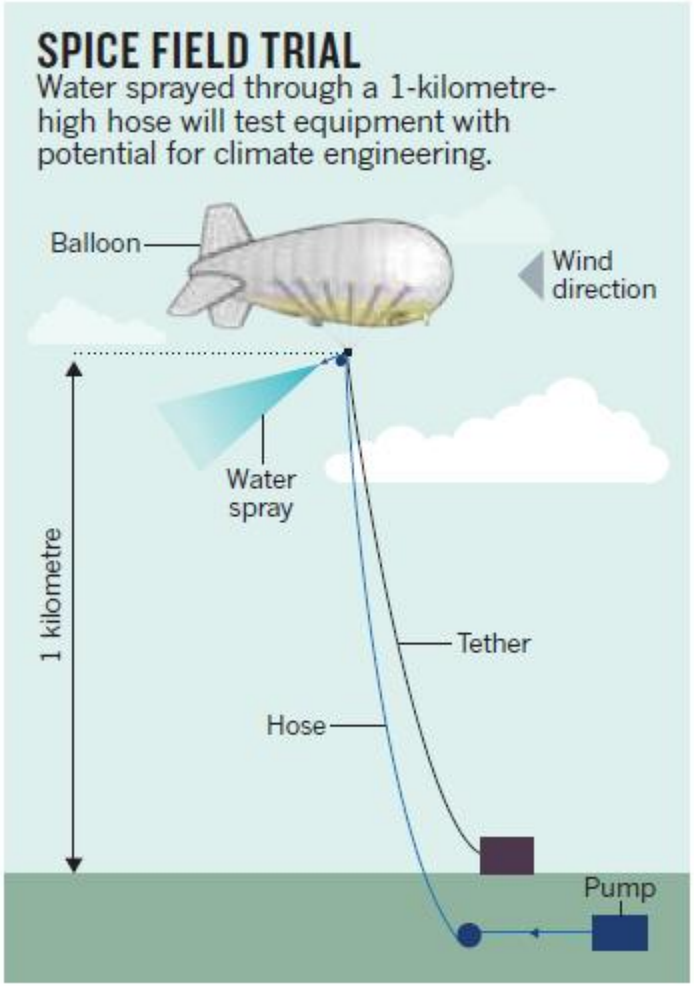


Figure Macnaghten and Owen, 2011

The Stakes:

A balloon 1 km high spraying water over Cambridgeshire

or

UK's 1st field trial of climate-engineering technology

Stage gating – oversight and governance

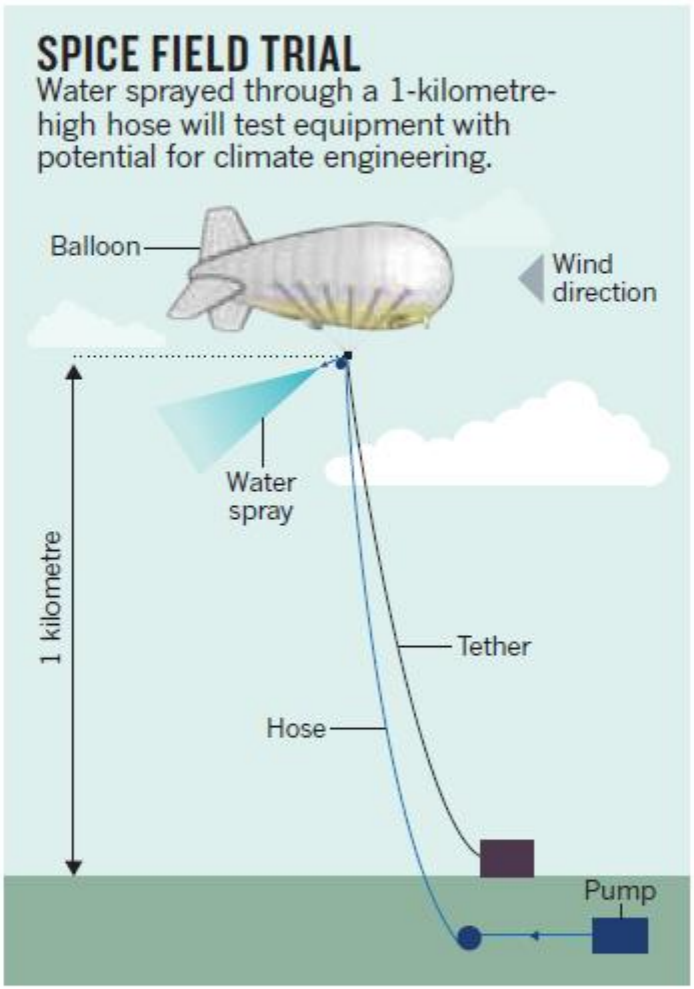
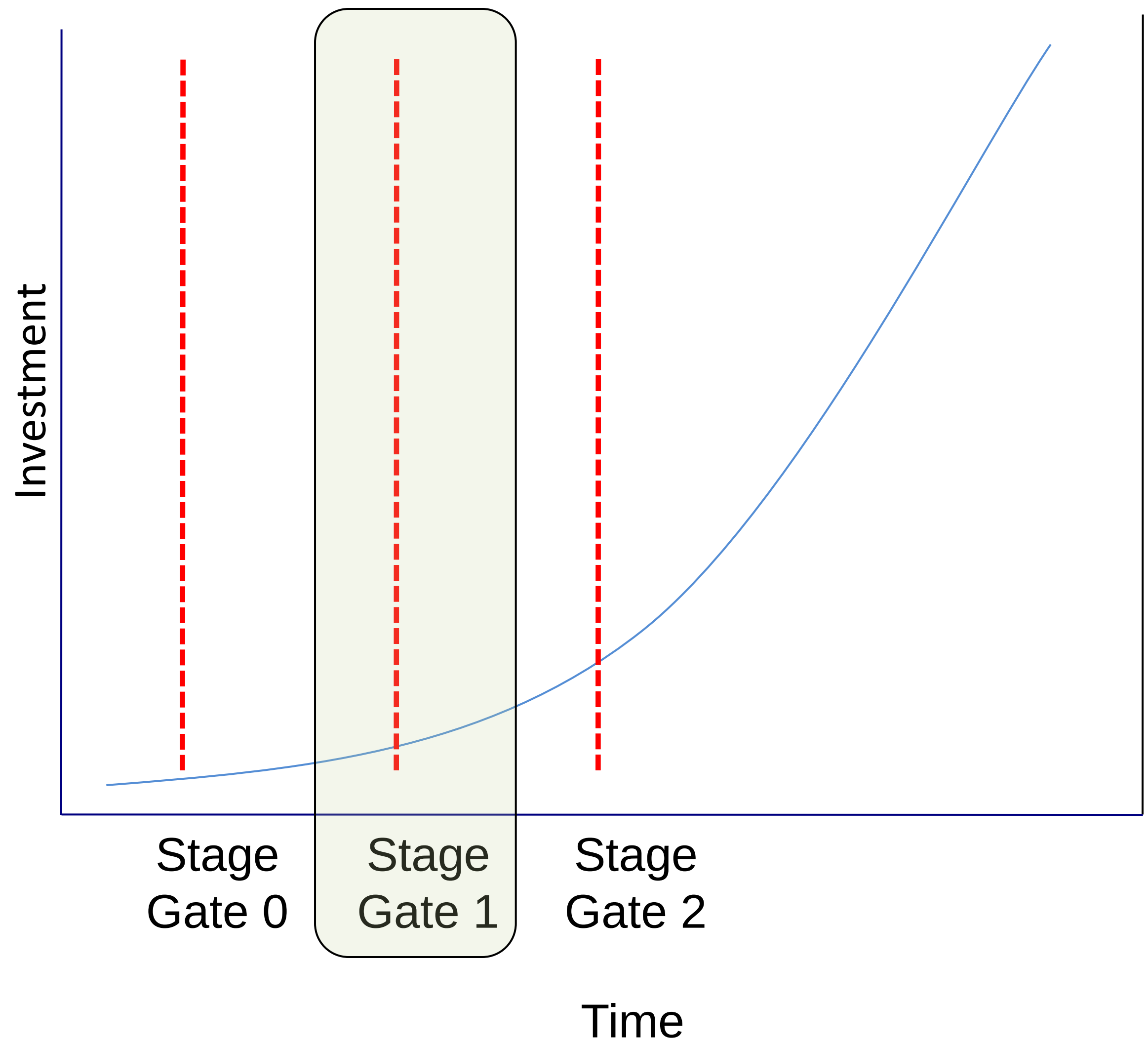


Figure Macnaghten and Owen, 2011



Responsible innovation (AIRR dimensions)

Anticipative

(describing and considering possible intended and unintended broad impacts)

Inclusive

(deliberating with and involving stakeholders, users and wider publics)

Reflexive

(reflecting upon embedded commitments and assumptions)

Responsive

(answerable to outside questions and flexible enough to adjust)

Responsible Innovation

Want to mimic a volcano to combat global warming? Launch a Wembley-size balloon

Monster blimp would fire water into atmosphere

Scientists hope droplets can reflect the sun's heat

John Vidal
Environment editor

It sounds barmy, audacious or sci-fi: a tethered balloon the size of Wembley stadium suspended 20km above Earth, linked to the ground by a giant garden hose pumping hundreds of tonnes of minute chemical particles a day into the thin stratospheric air to reflect sunlight and cool the planet.

But a team of British academics will later this month formally announce the first step towards creating an artificial volcano by going ahead with the world's first major "geo-engineering" field test in the next few months. The ultimate aim is to mimic the cooling effect volcanoes have when they inject particles into the stratosphere that bounce some of the sun's energy back into space, so preventing it from warming the Earth and diminishing the effects of man-made climate change.

Before the full-sized system can be deployed, the research team will test a scaled-down version of the balloon-and-hose design. Backed by a £1.6m government grant and the Royal Society, the team will send a balloon to a height of 1km over an undisclosed location. It will pump nothing more than water into the air, but it will allow climate scientists and engineers to gauge the feasibility of the plan. Ultimately, they aim to test the impact of sulphates and other aerosol particles sprayed directly into the stratosphere.

If the technical problems posed by con-

Scientists hope to replicate the

So imagine how big a helium balloon you need to hold several double-decker buses


Stop Geoengineering!
Hands Off Mother Earth
Our home is not a laboratory

Stage gating – oversight and governance

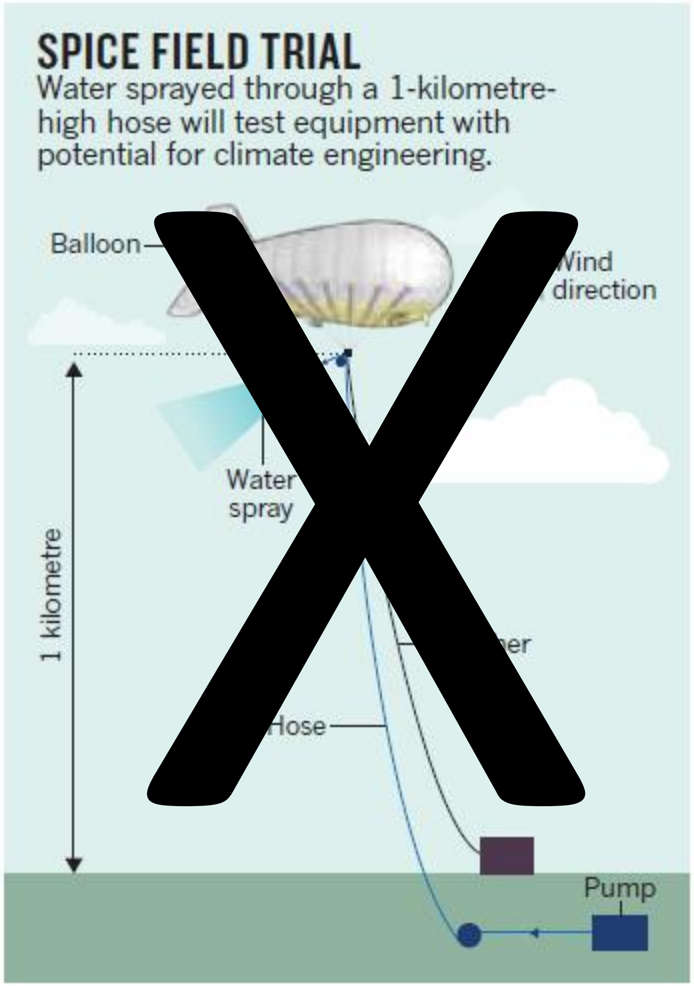
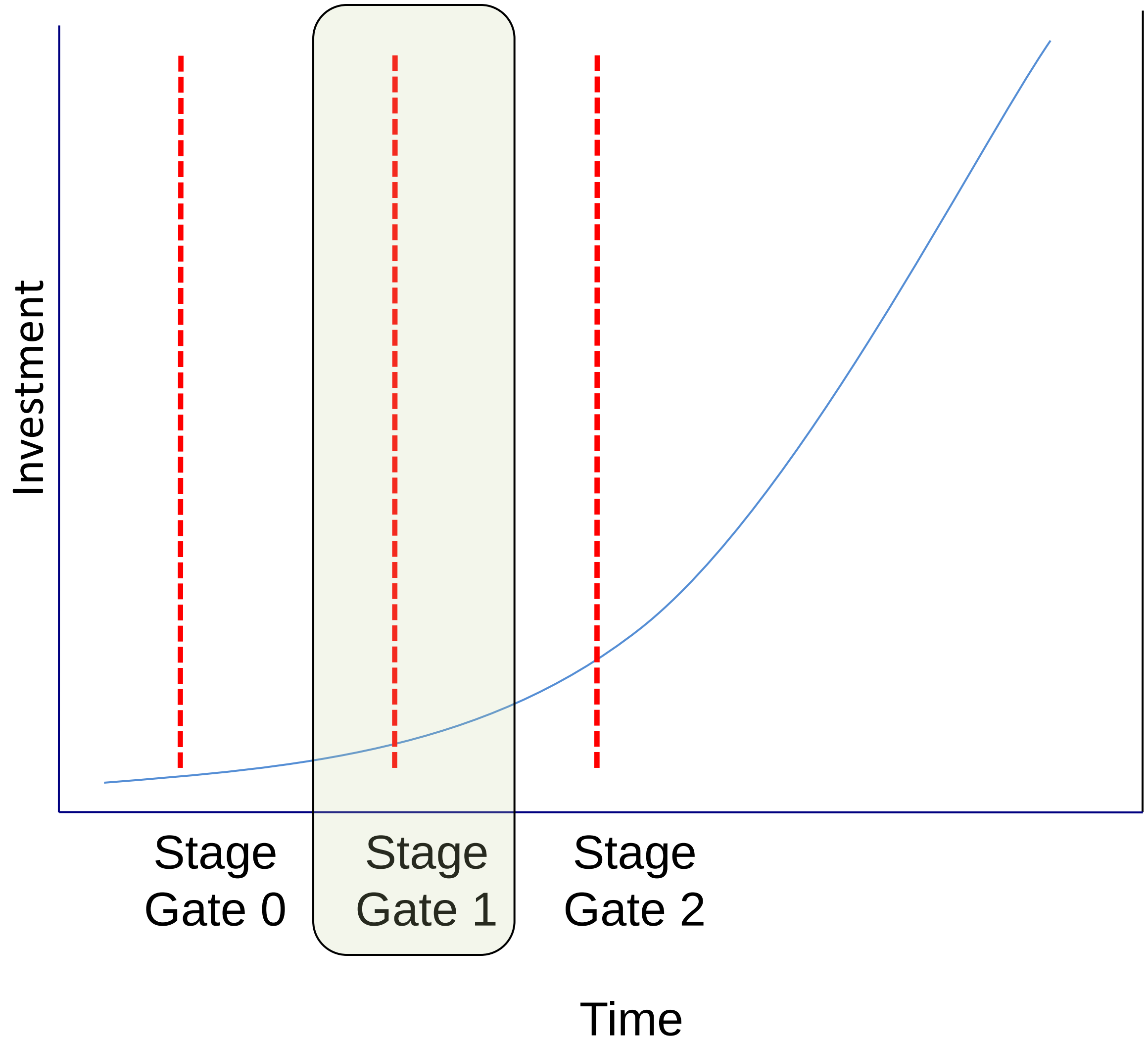


Figure Macnaghten and Owen, 2011



Good governance for geoengineering

Phil Macnaghten and **Richard Owen** describe the first attempt to govern a climate-engineering research project.

Climate-engineering research must have strong governance if it is to proceed safely, openly and responsibly[1,2]. But what this means in practice is not clear. The Stratospheric Particle Injection for Climate Engineering (SPICE) study demonstrates the difficult judgements involved. As chairman of the panel that supported decisions by the UK Engineering and Physical Sciences Research Council (EPSRC) as to whether and how this project should proceed (P.M.), and the architect of the project's governance process (R.O.), we draw lessons from these challenges.

In mid-September 2011, SPICE announced the go-ahead for the United Kingdom's first field trial of climate-engineering technology. SPICE aims to assess whether the injection of sulphur particles into the stratosphere would mimic the cooling effects of volcanic eruptions and provide a possible means to mitigate global warming. An equipment test — spraying water at a height of 1 kilometre — was proposed (see 'SPICE field trial'). No climate engineering would result from the test, but response to the announcement was dramatic, and the project was soon at the centre of a storm of criticism.

CAREFUL REVIEW

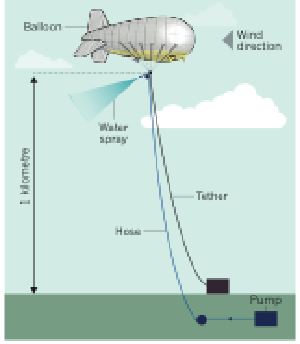
On 26 September 2011, the EPSRC, one of the study's main funders, postponed the trial after a review. Later the same day, the council received a letter and open petition[3], also sent to UK energy and climate-change secretary Chris Huhne and signed by more than 50 non-governmental organizations (NGOs) and civil-society organizations, demanding that the project be cancelled. The signatories saw the research as a first, unacceptable step towards a fix that would deflect political and scientific action away from reducing greenhouse-gas emissions. Others, by contrast, saw the research as urgently needed to find possible ways of coping with climate change[4]. The question at the heart of this debate was: should work in this controversial field proceed at all, and if so, under what conditions?

The strong feelings about the first test of SPICE's equipment show how important it is to have robust governance, and for scientists and funders to ensure that the public and other parties are consulted at the earliest opportunity. This is an unfamiliar and difficult process, but it is crucial for the evaluation of climate-engineering approaches.

SPICE was conceived in March 2010 at an EPSRC interdisciplinary workshop, at which researchers were invited to develop innovative geoengineering proposals. The project's funding incorporated field testing, but release of money was conditional upon it passing a 'stage-gate' review — a governance process in which funding for each phase of research and development is preceded by a decision point. To pass the review, SPICE scientists were required to reflect on the wider risks, uncertainties and impacts surrounding the test and the geoengineering technique to which it could lead — solar-radiation management.

On 15 June 2011, the stage-gate panel (including atmospheric scientists, engineers and social scientists, as well as an adviser to an environmental NGO) evaluated the SPICE team's response to five criteria for responsible innovation. These were that: the test-bed deployment was safe and principal risks had been identified, managed and deemed acceptable; the test-bed deployment was compliant with relevant regulations; the nature and purpose of SPICE would be clearly communicated to all relevant parties to inform and promote balanced discussion; future applications and impacts had been described, and mechanisms put in place to review these in the light of new information; and mechanisms had been identified to understand public and stakeholder views regarding the predicted applications and impacts.

SPICE FIELD TRIAL
Water sprayed through a 1-kilometre-high hose will test equipment with potential for climate engineering.



Recognizing the efforts of the SPICE team, the panel concluded that although the first two criteria had been met, more was required on the remaining three. It asked the team to develop a revised communications plan to inform further public debate, a review of the risks and uncertainties of solar-radiation management — including social, ethical, legal and political dimensions — and a thorough process of engagement with stakeholders.

The test bed was delayed by EPSRC in September to allow the team to undertake these outstanding actions. When the panel reconvenes, it will independently assess a revised response; until then, the project remains under review.

LESSONS LEARNED

Aspects of SPICE's governance could have been improved. The framework should have been in place before the project's conception; the test date should not have been announced until the stage-gate criteria had been met; and the structures and resources to support the social research should have been in place earlier. Even now, the decision on whether to proceed will not be easy. There are few right or wrong answers to the many questions about climate engineering. But it is vital that we make space to listen to and discuss these questions, and that the debate transparently influences the decisions that are taken.

For geoengineering technology to progress, its developers must be mindful of wider impacts from the outset; and it must proceed under robust governance mechanisms. The SPICE responsible-innovation framework is one evolving approach to achieving it. ■

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1. Royal Society working group *Geoengineering the Climate: Science, Governance and Uncertainty* (Royal Society, 2009) available at http://go.nature.com/zxpwun
2. Rayner, S., Redgwell, C., Savulescu, J., Pidgeon, N. & Kruger, T. *Memorandum on Draft Principles for the Conduct of Geoengineering Research* (House of Commons Science and Technology Committee Enquiry into The Regulation of Geoengineering; 2009).
3. http://www.handsoffmotherearth.org/hose-experiment/spice-opposition-letter/
4. Nurse, P. Letter to *The Guardian* 8 September 2011 available at http://go.nature.com/efnybg

RESEARCH
Our portfolio
Facilities and equipment
Centres and major investments
Case studies
Partnerships
Framework for Responsible Innovation
Anticipate, reflect, engage and act (AREA)
Support
Expectations
Acknowledgements and resources

FRAMEWORK FOR RESPONSIBLE INNOVATION

EPSRC is committed to develop and promote Responsible Innovation. This site reaffirms our own commitment and sets out our expectations for the researchers we fund and their research organisations.

INTRODUCTION

Responsible Innovation is a process that seeks to promote creativity and opportunities for science and innovation that are socially desirable and undertaken in the public interest. Responsible Innovation acknowledges, that innovation can raise questions and dilemmas, is often ambiguous in terms of purposes and motivations and unpredictable in terms of impacts, beneficial or otherwise. Responsible Innovation creates spaces and processes to explore these aspects of innovation in an open, inclusive and timely way. This is a collective responsibility, where funders, researchers, stakeholders and the public all have an important role to play. It includes, but goes beyond, considerations of risk and regulation, important though these are.

As a public funder of research, we have a responsibility to ensure that our activities and the research we fund, are aligned with the principles of Responsible Innovation, creating value for society in an ethical and responsible way. EPSRC does not wish to be prescriptive about how Responsible Innovation is embedded in the research and innovation process. We recognise that some researchers are already well engaged

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Home > Research > Framework for Responsible Innovation > Anticipate, reflect, engage and act (AREA)

ANTICIPATE, REFLECT, ENGAGE AND ACT (AREA)

A Responsible Innovation approach should be one that continuously seeks to:

Anticipate – describing and analysing the impacts, intended or otherwise, (e.g. economic, social, environmental) that might arise. This does not seek to predict but rather to support an exploration of possible impacts and implications that may otherwise remain uncovered and little discussed.

Reflect – reflecting on the purposes of, motivations for and potential implications of the research, and the associated uncertainties, areas of ignorance, assumptions, framings, questions, dilemmas and social transformations these may bring.

Engage – opening up such visions, impacts and questioning to broader deliberation, dialogue, engagement and debate in an inclusive way.

Act – using these processes to influence the direction and trajectory of the research and innovation process itself.

EPSRC Centres for Doctoral Training

Call type: Invitation for outlines

Closing date: 16.00 hrs 4 April 2013

Related themes: All

Responsible innovation

Science and innovation not only produces understanding, knowledge and value, but it can result in unintended impacts, questions, and ethical dilemmas and, at times, unexpected transformations in social life. In EPSRC we recognise that we have a duty of care to promote approaches to "responsible innovation" which will initiate ongoing reflection about the potential ethical and societal implications of the research that we sponsor on behalf of the taxpayer and to encourage and train our research community to do likewise.

As a research sponsor, our aim is to build capacity within our research community to discuss and consider social and ethical questions. A key element in building awareness and capacity will be through appropriate multi-disciplinary training embracing aspects such as social science and ethics. However, we feel we should not be prescriptive about such training but rather students and their supervisors should be allowed to be imaginative and develop and discuss what is appropriate within a broad framework.

EPSRC would like to encourage training around the concepts of responsible innovation. In doing so you may wish to seek to consult and work with others outside of the EPS sphere e.g. social scientists, ethicists and public engagement experts.

Technology Strategy Board
Driving Innovation

Responsible Innovation Framework

for commercialisation of research findings

For use in synthetic biology feasibility studies competition 2012:

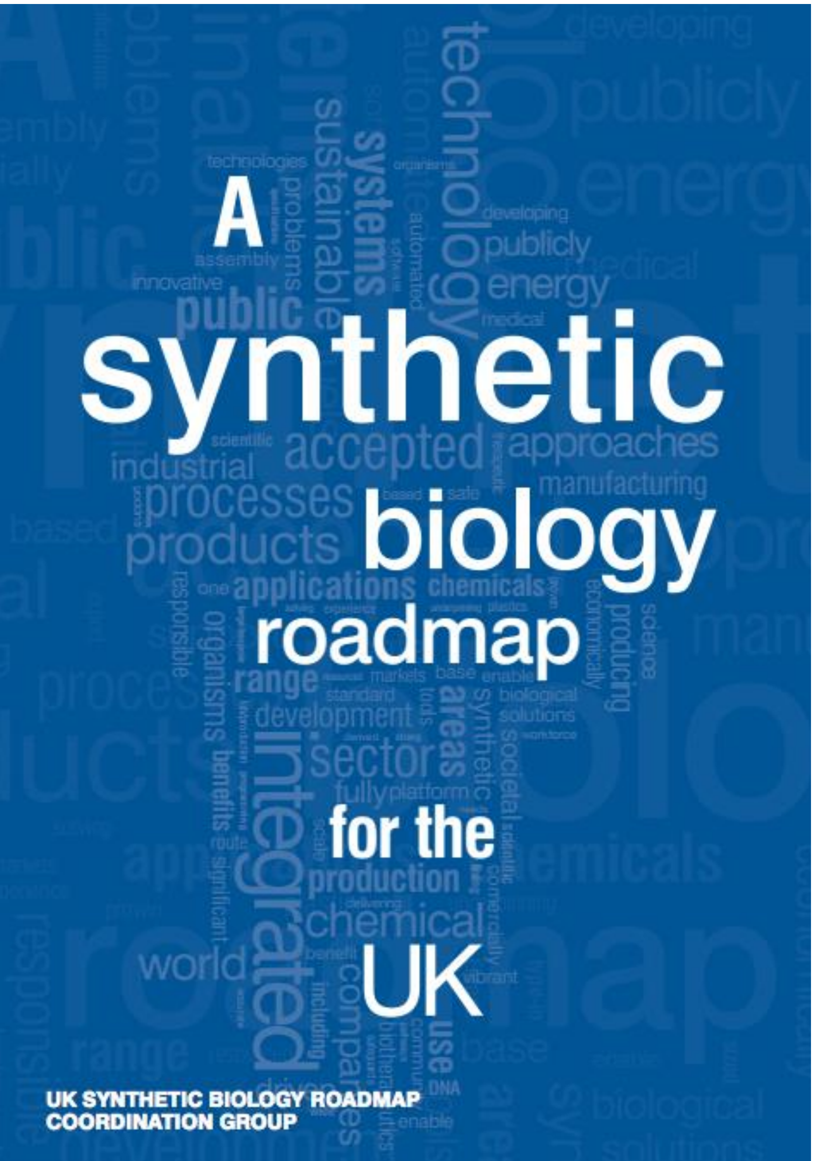
Advancing the Industrial Application of Synthetic Biology

Driving responsible innovation

The Technology Strategy Board is the UK's innovation agency and a non-departmental body working under the sponsorship of the Department for Business, Innovation and Skills of the UK Government. Our role is to help UK businesses to develop new products, processes and services to generate wealth and grow the economy.

Synthetic biology is a technology which, if used appropriately and responsibly, has the potential to address major societal and environmental challenges and help grow the economy. It has the potential to contribute to the creation of a sustainable economy in which there is universal and continuous access for current and future generations to the resources and opportunities needed to live well.

Technology Strategy Board and its partners are keen to ensure that all the projects they fund in this area use innovation responsibly and are using this Responsible Innovation Framework as part of this competition.



Theme 2:
Continuing responsible research and innovation

It is crucial that this technology continues to be developed in a socially responsible fashion, and that relevant stakeholders, regulators and the public are engaged in research and innovation processes from the outset. Responsible research and innovation encompasses, but is not confined to, operating within an effective risk regulatory framework. The UK needs to be, and to be seen to be, leading the way in frameworks and methodologies for responsible innovation. The UK has already initiated public dialogue in synthetic biology and encouraged interaction between regulators and funders.

Since synthetic biology is a new field, there is much uncertainty surrounding both the risks and benefits of its research and applications. While stringent risk management is crucial for responsible research and innovation, inescapable uncertainty must be acknowledged and accounted for. The aim of responsible research and innovation is not simply to predict and proactively manage negative outcomes, but also to shape decision-making procedures that recognise such uncertainty across the whole life cycle of innovation. To foster successful innovation, governance must be flexible, transparent, open to wider participation, and responsive to emerging evidence and changing social priorities.

Public acceptability

Public acceptability is widely recognised as a crucial issue for synthetic biology, but it cannot be adequately dealt with through communication aimed at reassuring the public. Prior public controversies on emerging technologies demonstrate that it is essential for debates to go beyond the community of experts to open up discussions about the purpose of innovation and about uncertainties and complexities surrounding both the benefits and risks associated with particular applications. Research has shown that 'the public' is not a singular pre-existing mass that accepts or rejects particular technologies according to fixed preconceptions. The direction taken by innovation pathways, and their perceived social consequences, themselves shape public responses. The responses and decisions of many and varied social groups – alongside those of academic researchers and firms – help to determine technological pathways and the realisation of benefits. These include institutions involved in health, safety and environmental regulation, intellectual property, research funding, and capital investment, as well as intended users and beneficiaries, and civil society groups. New social groups also emerge alongside innovation (new pressure groups may come into being when, for example, a new drug is developed to extend the life of patients with a specific terminal cancer). All of these groups need to be actively engaged, throughout the process, in the governance of synthetic biology research and innovation.

In the UK, public acceptability was recognised as crucial from an early stage and led to a large-scale synthetic biology dialogue in 2010. Findings from the dialogue showed there was support for synthetic biology but that this was conditional. While there was great enthusiasm for the possibilities of the science and its application, there were also fears of control and misuse and concerns about how to govern this novel area when there is uncertainty over its outcomes. One of the key findings of the dialogue – which is consistent with a large body of social science research – was the emergence of these five key questions that synthetic biologists should be willing and able to answer[17]:

- **what is the purpose?**
- **why do you want to do it?**
- **what are you going to gain from it?**
- **what else is it going to do?**
- **how do you know you are right?**

To build on this successful dialogue, it is crucial that these questions are at the forefront of ongoing decisions about the commercialisation, translation and regulation of synthetic biology. Indeed, BBSRC, on behalf of the UK research councils, posed these questions in the closing session of the Six-Academy Synthetic Biology Symposium II in Shanghai in October 2011[18]. Although addressing health, environmental and security risks is important, this will not in itself lead to broad public acceptability unless innovation in synthetic biology is demonstrably directed towards:

- **new products, processes and services** that can bring clear public benefits including, but not limited to, employment, improved quality of life and economic growth
- **solutions to compelling problems that** are more effective, safer and/or cheaper than existing (or alternative) solutions.

Integrating social sciences, humanities and arts researchers can help with understanding of, and engagement with, such issues and thus foster responsible innovation. The UK is at the forefront of experimenting with such cross-domain collaborations: the seven synthetic biology networks included social scientists, artists, philosophers, and legal scholars; and the Imperial College Centre for Synthetic Biology and Innovation (CSynBI) was set up as a joint centre between scientists and engineers at Imperial College and social scientists at the BIOS research group[19].

17 BBSRC/EPSRC (2010) Synthetic Biology Dialogue. Swindon, Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC), p.7. Online at: www.bbsrc.ac.uk/web/FILES/Reviews/1006-synthetic-biology-dialogue.pdf
For a summary of how these same issues recur throughout all the ScienceWise Dialogues, see Chilvers, J and Macnaghten, P. (2011) *The Future of Science Governance: A review of public concerns, governance and institutional response*. London: Sciencewise-ERC. Online at www.sciencewise-erc.org.uk

18 Six Academies Synthetic Biology Symposium II – Shanghai 12 – 14 October 2011, www.sibs.ac.cn/synbioprogramme.asp

19 BIOS – a centre for Biological Sciences originally based at the London School of Economics (LSE) and now based in King's College London

Responsible innovation and the role of universities – 4 challenges

1. Training and new curricula
   - A forum for interdisciplinarity and collaboration
   - A space for reflection on how to approach the challenges of today and tomorrow

WAGENINGEN UR
For quality of life

Responsible innovation and the role of universities – 4 challenges

2. Shaping institutions
   – Research councils and funding agencies
   – Research organisations and networks
   – Policy institutions including regulators

Responsible innovation and the role of universities – 4 challenges

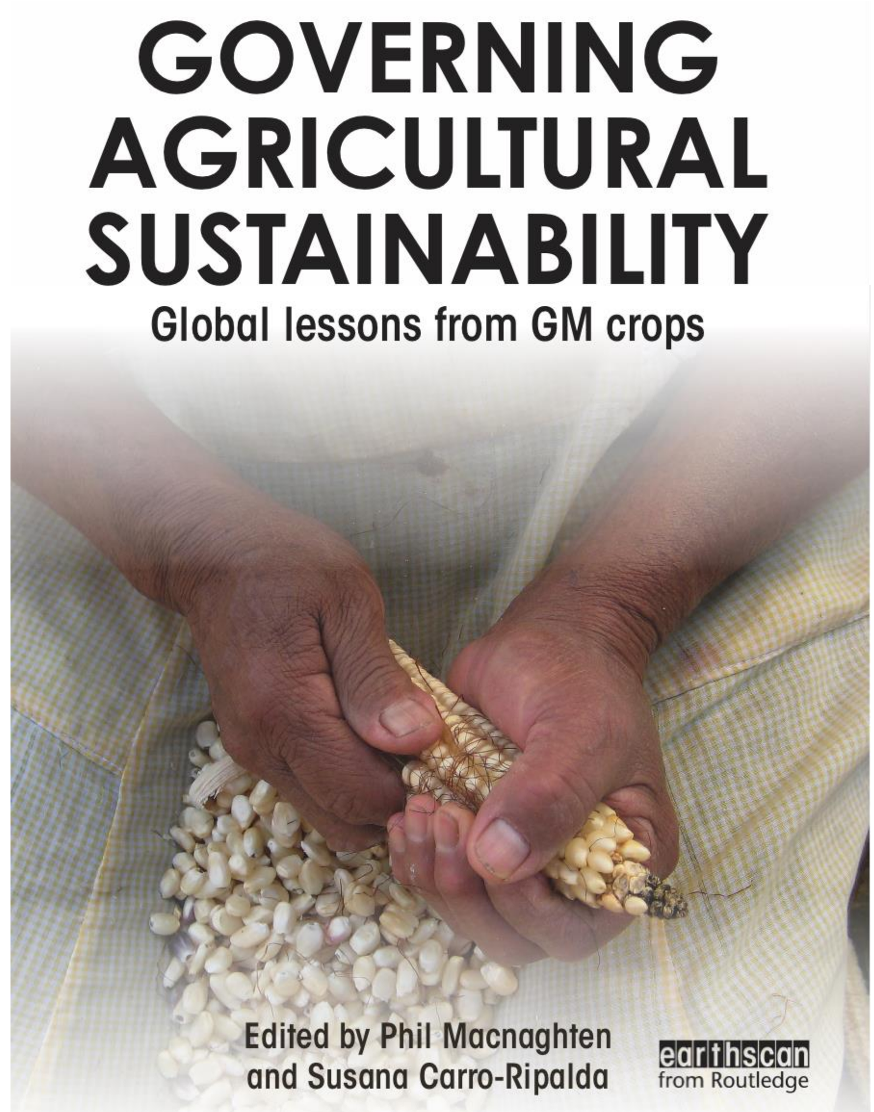
3. Scientific diplomacy
   - Need for more responsive science policy institutions beyond Europe
   - How to motivate change in complex institutions in culturally sensitive manners
   - Europe (and European values) as one highly important source of new ideas

FAPESP

UNICAMP

Responsible innovation and the role of universities – 4 challenges

4. Opening up debates on the governance of old technologies in new ways



Thanks

Also to Richard Owen and Jack Stilgoe