

RISING TO THE CHALLENGE OF RESPONSIBLE INNOVATION



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Our capacity for creativity and innovation is limited only by our imagination. The society in which we live is the cumulative product of thousands of years of human innovation. This has continuously shaped society since the dawn of Civilization, from the first flint tools to the plough, from the printing press to the internet. I remember when I was studying for my PhD in the early nineties a new technology called 'email': it was slow, with dial up connection and no ability to send attachments. But we academics loved it: it was cheap and great if you needed to communicate almost instantaneously with another isotope chemist in the US or Japan (I'm sure many of you reading this have had this need). Now I can pick up and respond to a work email while shopping in Sainsbury's. There's no going back, it's here to stay, at least until something better comes along. This is what we call 'technological lock in', when new innovations become indispensable to our modern lives.

But here's a question: while you are working how often do you quickly check your email? Will you take a quick peek at your Inbox before you finish this article? Some are concerned that by continuously stopping to check our email we are damaging our ability to think in

a deep and meaningful way. What has been described as 'divided attention disorder' led one broadsheet to suggest email is making us become 'lab rats craving pellets of social interaction'. Now whether or not this is the case, it serves to illustrate two important things about innovation, particularly that which we call 'disruptive': the future wider impacts of science and technology are always uncertain, and they are usually unpredictable. Who would have guessed that email might result in divided attention disorder, or that coal fired power stations and cars would have significant impacts on global climate? Or that CFCs in our refrigerators would cause a large hole in the ozone layer? Or that a neat little piece of financial innovation called securitisation would cause global chaos in the banking sector. 'We didn't see it coming' a former PM remarked.

The uncertainty and unpredictability of the wider impacts of innovation present a problem for Governments, particularly if they place innovation as a central pillar in their economic growth policy. Back in the 1980's David Collingridge called it the 'dilemma of control'. In essence the dilemma is this: at the early stages of innovation there is sufficient opportunity for control but insufficient evidence of

wider impacts to justify this, for example through new regulation. Later on however, once the technology is more fully developed, there may be enough evidence of wider impacts to make the case for regulatory control. But now it is too late: the technology is locked in to society, it has become indispensable and the investment losses would be too great. A ban on mobile phones may have been possible back in the days when they were the size of a brick. But now? They are as locked into society as the internet.

Reflecting this, over the years regulation has attempted to 'move upstream'. We now have 'data before market' legislation for things like industrial chemicals and pharmaceuticals. Regulation is quite good for controlling the type of thing it already knows about eg the registration of a new pharmaceutical active. But it struggles with things it hasn't encountered before, for example a carbon nanotube, or a synthetic organism. These types of innovation increasingly occur at the convergence of established scientific disciplines such as chemistry, biology and engineering and at the margins of current regulation. They do not intentionally set out to transgress the law. It's more that such innovations happen precisely where the law is not well established, where it is incomplete or unclear, where there is a 'regulatory gap'. The result is that innovation leaps ahead, and evidence based regulation follows, years and even decades later.

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I can remember the first discussions about regulation of nanotechnology in 2004 after a major report by the Royal Society and Royal Academy of Engineering. Here the concerns were (and arguably still are) whether, if materials radically change their properties when manufactured at the 'nanoscale', (a billionth of a meter) they also present radically different risks. Carbon as graphite we think of as being rather benign, but what about a carbon nanotube, described by some as 'the hottest thing in physics' and others as having 'asbestos-like properties'? Questions were asked: is this technology safe? Is it properly regulated? These are yet to be fully answered.

So it was with a great sense of *déjà vu* that I heard these questions come up again at a recent Parliamentary and Scientific Committee meeting concerning another radical new technology, synthetic biology. Synthetic biology uses developments in engineering and biology to synthesise genetic material that can be used to create new organisms, or useful parts of them, or to redesign existing organisms. Our ability to synthesise and manipulate DNA, the building blocks of life, moves us from (as Craig Venter described it) 'reading the genetic code to writing it'. From the creation of artificial chromosomes to 'viruses from scratch', the ability to engineer life has huge potential benefits, from biofuels to antimalarial drugs. A recent public dialogue highlighted that, like nanotechnology, while people could see these potential benefits, they also have some big questions: Is it safe? Is it properly regulated? And some others that come up time and time again when new technologies emerge in the public consciousness. Should they be doing it? Could it be

misused? What is its purpose? Who benefits? What will the wider impacts be in the future? Are these acceptable? Is it ethical, are they playing God? Sometimes, as in the case of nanotechnology, these questions take the form a low background hum, but sometimes, as in the case of nuclear power, they can be far more audible. This seems to be particularly the case when scientists delve into the genetic machinery that is the basis of life on this Planet, as we saw with GM. People get concerned about the sanctity of life, when the boundaries of what is natural and what is synthetic become blurred.

These questions are central to people's hopes and fears for new technologies. Wonderment at the potential for innovation to improve our lives is tempered by anxiousness about whether it is safe and ethical, about whether we will actually benefit or simply be burdened with the risks. These questions need to be addressed early on, at a time when there is an opportunity to shape and influence the trajectory of science and innovation. As Jeff Goldblum famously said in the film *Jurassic Park*: 'scientists were so preoccupied with whether or not they could, they didn't stop to think if they should'.

This is not, I stress, synonymous with stifling high adventure science and creativity. This is a very important point. It's about constructively supporting it in a way that demonstrates a genuine and visible commitment to responsible innovation, opening it up in a way that promotes trust and ultimately means that innovation is sustainable. This is exactly what the public want: a clear message from the synthetic biology dialogue was that the public want scientists to think about the wider impacts of

their research, to think about the questions that always crop up, and for those that fund them, particularly with public money, to play an active role. Responsibility cannot be outsourced to someone else at some future point.

But what in practice does this mean? In 2009 I began to explore this with the Engineering and Physical Sciences Research Council (EPSRC), the largest public funder of innovation research in the UK. I had been invited to scope a major research funding call at the convergence of two major fields of disruptive innovation: nanoscience and geoengineering. It was a call for proposals to investigate the potential for nanoscience to facilitate carbon capture from the atmosphere, an ideal opportunity to trial something rather different¹. For the first time we asked scientists applying for funding to submit a 'risk register' in which they documented what they saw as being the potential wider impacts and risks of their proposed research, how these would be managed and by who. This began to get them to think about the questions 'is it safe, are there any wider risks?' Some of them thought very carefully about these, and when I interviewed them all the applicants said it was something they should be doing. They just needed the mandate and guidance to do it properly.

To my surprise (because they had not been explicitly asked to do so) some of them began to think about the other questions too, proposing public dialogue exercises around the innovation research core, building in mechanisms to identify wider impacts as these emerged and feed these back into the direction of their research. There were grant proposals with not

only synthetic combinatorial chemists but social scientists and environmental scientists working as a team, beginning to think these issues through at the outset of their planned research.

Building on this the Economic and Social Research Council and EPSRC are beginning to think about how we could develop a Responsible Innovation Framework, which could eventually be used by Research Councils and those who apply to their funding calls. Some very progressive thinking is being done about this. My hope is that this could provide the guidance and tools to ensure we are in a better position to ensure that innovation is, and is seen to be, responsible, acceptable and ultimately sustainable. Not only that, but if we are clever and ensure there is good communication between this process within the Research Councils and those developing policy we stand the best chance of developing regulation that is proportionate and shaped by debate in an inclusive, open and timely way.

A new model of responsible innovation needs to include regulation, but it needs to acknowledge the issues that radical innovation poses for it. It challenges us as scientists, as funders of science, as Members of Parliament, as citizens, to face the questions that come up time and time again and think about what our roles and responsibilities are in answering these. Rising to this challenge is not easy but is critical for shaping future society and the World we will live in. It is a challenge well worth rising to.

¹ Owen R and Goldberg N (2010) Responsible Innovation: A Pilot Study with the UK Engineering and Physical Sciences Research Council. *Risk Analysis*, Vol 30, No 11, 2010 DOI: 10.1111/j.1539-6924.2010.01517.x

