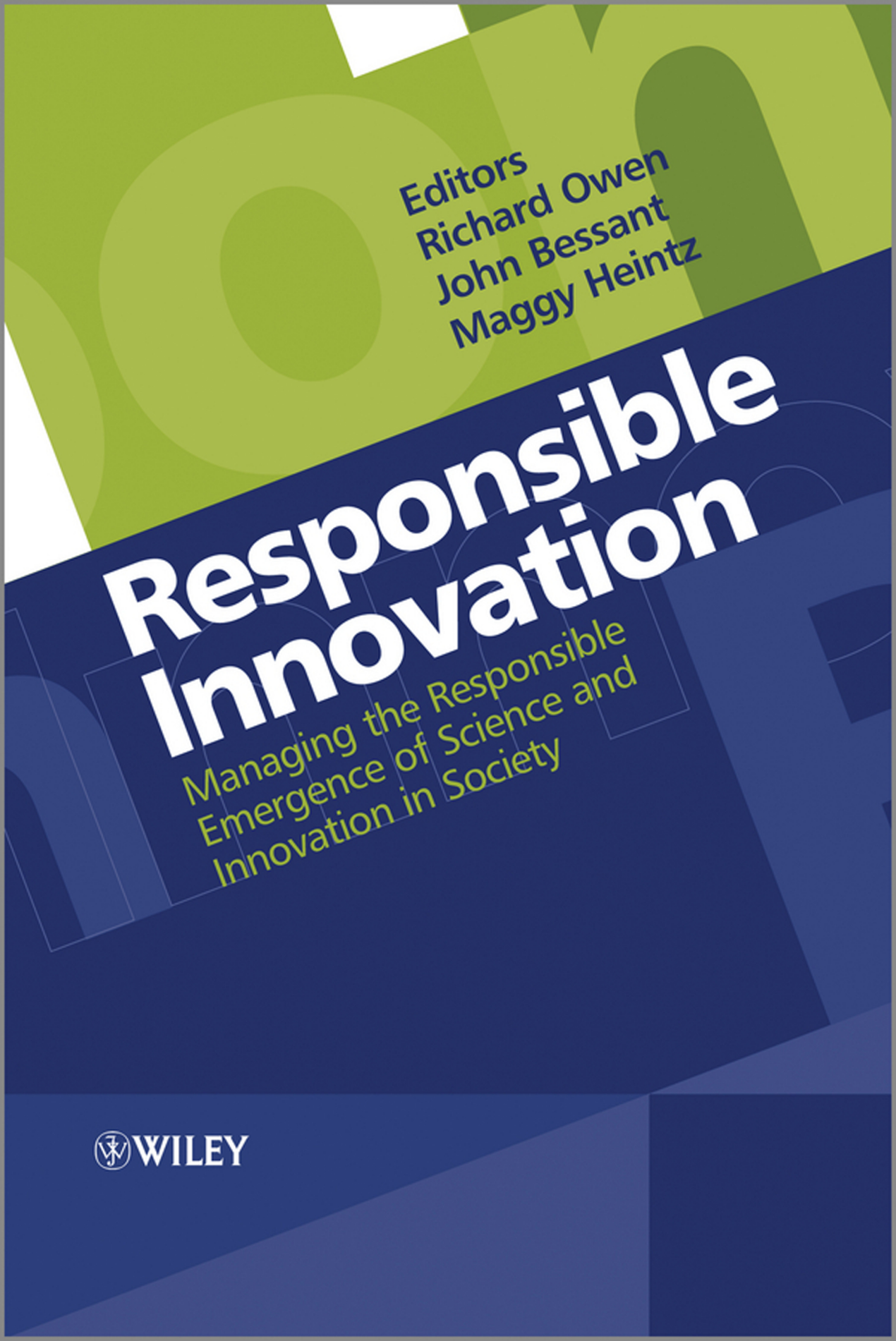
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Responsible Innovation
Managing the Responsible Emergence of Science and Innovation in Society
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Responsible Innovation

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Managing the responsible emergence of science and innovation in society

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Foreword: Why Responsible Innovation?

Jack Stilgoe

> *This disparity between rich and poor has been noticed . . . Whatever else survives to the year 2000, that won't. CP Snow,* The Two Cultures *(1959)*

CP Snow's 1959 Rede lecture is most famous for the dichotomy that it diagnosed (and so exacerbated) between the sciences and the arts. Snow's feeling was that, if science was to realize its almost limitless potential, it needed to better connect with the cultures around it. In going on to make a prediction that science would alleviate global poverty within four decades, Snow was not the first clever man to be let down by his foresight. Quotes from leading innovators (almost certainly apocryphal) that reveal a laughable pessimism are readily Googleable: "I think there is a world market for maybe five computers" (Thomas Watson, founder of IBM); "Some day, every town in America will have one of these" (Alexander Graham Bell, talking about the telephone). Snow's prediction fell the other way. So optimistic was he about the power of science that he imagined even the toughest social problems would succumb to a technological fix soon enough.

Here we are, five decades later and twelve years after Snow's deadline. The gap between the global rich and global poor has got larger, while the productivity of science has exponentially increased. Science, as Francis Bacon described it, is about both "intellectual enlightenment" and "the relief of man's estate." One could be forgiven for thinking there had been rather more emphasis on the former than the latter.

It is clearly unfair to focus on the unmet promises that others have made for science while ignoring its vast, often unpredictable, often serendipitous benefits. At least in rich countries, the products of scientific research and technological innovation are visibly woven into our everyday lives. And even in those countries where people do not see the same share of benefits, there is unarguable evidence of science-led progress in medicine, agriculture and other areas. But if we let science and innovation take credit for these transformative advantages, we should not be afraid of also asking where responsibility lies for the unrealized promises and unintended consequences of innovation. The broad

aim of responsible innovation is to connect the practice of research and innovation in the present to the futures that it promises and helps bring about.

Discussions of responsibility in science often zoom in on individuals. We point to heroes such as Jonas Salk, who gave away the Polio vaccine that he invented, or Joseph Rotblat, the physicist-turned-nuclear disarmament campaigner. And we have our caricatured antiheroes – Drs Frankenstein, Strangelove and co. This emphasis on individual morality gives us codes of conduct or Hippocratic Oaths, but it gets us no closer to understanding why Snow made his grand prediction, nor why the world has failed to live up to it. We must instead find ways to analyze, describe and change how systems of innovation engage, not just with their intended or envisaged futures, but with a full range of implications. The connection between scientific discovery and innovation is not as straightforward as many scientists would like to claim. This linear model is less fiercely defended when things go wrong. The pattern in the past has been that, in matters of innovation, science takes the credit while society gets the blame. Innovation is rarely so heroic.

With a systemic view, we can see the problems clearly enough. According to one analysis, 90% of the world's pharmaceutical research is targeted at the common diseases of the richest 10% of the world's population (the so-called "90/10" gap). This sort of imbalance is not inevitable. There are reasons why the world's combined innovative capacity has spewed forth iPhones and space shuttles but not yet managed to produce clean energy or universal access to clean water. If such inequities trouble us, we might explain them away as an artifact of conventional market and political mechanisms. Or we might choose to interrogate science and innovation themselves.

Once we lift the lid on innovation to reveal its politics, we can start to see that, for all of the good intentions of individual researchers, innovation can be a form of what Ulrich Beck calls "organized irresponsibility." Scientists may insist that efficient science demands autonomy – "let us get on with the research; society can worry about the implications." This division of moral labor follows a perennial science policy debate, played out in another era between Michael Polanyi and J.D. Bernal, about the desirability of controlling the direction of scientific research. A university research scientist, facing growing administrative burdens and shrinking research budgets, might argue that Bernal has won the day. But, when it comes to questions of responsibility, Polanyi's maxim that "you can kill or mutilate the advance of science, [but] you cannot shape it," still echoes.

This book is a response to a problem – innovation's systemic irresponsibility – as well as a progress report on a range of activities that have, from different directions, tried to improve the situation. As David Guston describes in Chapter 6, emerging technologies have become a testing ground for new approaches to governance. Fisher and Rip (Chapter 9) take nanotechnology as an example, Stahl and colleagues (Chapter 11) focus on information and communication technologies (ICT), Parkhill and colleagues (Chapter 12) consider geoengineering and Guston himself points to the debate about synthetic biology. The hope is that, before these technologies are fully formed, we might be able to nudge their trajectories in various ways toward responsible, desirable futures. These radically innovative areas are the sites of both scientific and governance experiments. Scientists and research funders in Europe, the United States and elsewhere, have recognized the need for new forms of public engagement (see the Chapters 5 and 12) and interdisciplinary collaboration (Chapters 6 and 9). There is a growing recognition that the

questions brought to the surface by each Next Big Thing (Who benefits? Who decides? What are the risks? Who's in control? What if we're wrong? What are the alternatives? Who's responsible? etc.) are not unique to a particular technology and they will only get louder as research presents ever more disruptive possibilities for intervention, be it in our genes, our natural environments, our economies or our private lives. The alternative ways of governing described in this book should be taken as an antidote to the narrative of inevitability that often accompanies new technologies. As befits an approach that is sceptical of technological fixes, tools such as public dialogue, constructive technology assessment, foresight or codes of conduct should not be taken as panaceas. The tools that are used should follow from the strategies that are adopted. Responsible innovation knits together activities that previously seemed sporadic or piecemeal.

The idea of Responsible Innovation, if it takes off, will be buffeted by political and economic headwinds. Those rich western economies that have historically oligopolized science and innovation now face economic crises of varying depths. These have narrowed the minds of policymakers, pushing environmental, global and intergenerational responsibilities down the agenda. De facto policies of hoping for the best and letting the future take care of itself appear to be taking hold. Public funding for science, at least in Europe and the United States, is static or waning, and researchers are expected to demonstrate that they are having ever-greater economic impact. The scientists' response, that it is foolhardy to predict and pick winners given the vagaries of research, is understandable. They might extend the same reasoning to responsible innovation, arguing that responsibility demands foresight, which, as CP Snow and others have discovered, is notoriously unreliable (see Chapter 7). Prediction is impossible, but anticipation of possible, plural futures is vital. The flipside of Polanyi's call for scientific autonomy is a rejection of the possibility of anticipation, which Guston argues is so vital, and so of responsibility.

The emerging thinking on Responsible Innovation contained in this book should help scientists assert their public value. Alongside governmental diktats to squeeze economic growth from science and innovation we see a growing policy interest in science tackling so-called "Grand Challenges" of sustainability, global health and food, water and energy security (see Chapter 3). Responsible innovation should help provide the foundation for policies that take grand challenges seriously. Responsible innovation seeks to avoid the problems of new technologies, but it also points to new opportunities. Cautionary tales of irresponsible innovation should be accompanied by stories of new innovation possibilities created through closer attention to particular responsibilities, such as the emergence of the world-beating Danish wind energy industry, following concerted Government policies that combined environmental and economic priorities.

If Responsible Innovation is to be viewed as a constructive endeavor, it must escape a predominant perception that is about regulation – saying "no" to things. Indeed, if Responsible Innovation is to make a difference, it will be through questioning the separation between innovation and regulation.

There's a game played at British village fetes called "splat the rat." The equipment is no more complicated than a piece of pipe, three or four feet long, nailed to a board. An over-confident child waits at the bottom of the pipe with some sort of whacking device – old cricket bat, grandfather's shoe, that sort of thing. The stallholder – let's say it's the vicar's wife – holds the toy rat in the top of the pipe. She lets the rat go. The child can either wait until the rat shoots out of the bottom or swing wildly at the plank beneath

the pipe, anticipating the rat's arrival. Either way, the odds are against the child leaving with a prize. Nine times out of ten, the rat shoots out of the end of the pipe, unsplatted. The vicar's wife tries to hide her smile as another child walks away disappointed.

In pharmaceutical companies, innovation is often referred to as a "pipeline." Money and brainpower go in one end and useful technologies come out of the other. The governance of innovation, in such a model, happens at the end of the pipe. The regulator is the child with the splatting device, waiting for innovations to emerge. The regulator has to anticipate the arrival of the innovation and react accordingly, although the timing, size and shape of the particular technologies that emerge may all be unknown. Whether or not these innovations are controlled in the public interest is largely a question of luck.

We have become familiar with the limits of this regulatory duel. As Petts and Lee describe in Chapter 8, attempts to rationalize regulation, to make it more "risk-based", fail to acknowledge how little we know about the risks of new technologies. There is a litany of regulatory failure, from asbestos, through Thalidomide, to Mad Cow Disease and beyond. These cases strengthen arguments in favor of the precautionary principle, giving the child a bigger thing to whack with, asking the vicar's wife to tip back her pipe to slow down the rat, or demanding a transparent pipe. But there are those who argue that precaution has gone too far, stifling innovation. Transhumanists and others have started to talk about a "proactionary principle" that tips the balance of regulation back in favor of innovators. These arguments, which imagine innovation as a runaway train that can only be sped up or slowed down, are a reflection of failures further upstream. They presuppose a clear division of responsibility between innovator and regulator. If we are to imagine innovation being steered in more responsible directions, we need to bring these two imagined sets of interests together.

As Fisher and Rip describe in Chapter 9, a Responsible Innovation perspective distributes responsibility more evenly. The chapters in this book do not presume that the world can be divided into those who would promote technologies and those who would control them. There needs instead to be collective conversations, not just about the products of innovation, but also the purposes of innovation, the directions in which innovation appears to be pointing. Fisher and Rip refer back to earlier developments (pioneered by Rip and colleagues) in "constructive technology assessment" to make the point that, because technologies "co-evolve" from the interactions of many different interests, so we should see responsibility for their direction as a collective one.

This book tries to bring intellectual coherence to a diverse set of practices. But it also strives to be useful. Responsible Innovation is necessarily responsive, in two senses of that word. First, asking the questions is not enough. We need to start demanding answers, particularly from those institutions involved in the governance of innovation. And second, we need to make our innovation systems more flexible, more resilient and more resistant to various technological lock-ins.

In the UK, the Engineering and Physical Sciences Research Council have recognized the need for a systematic approach to Responsible Innovation and have been open-minded enough to involve me and others in their thinking. The framework that we outline in this book (Chapter 2) is, we hope, both coherent and practically applicable.

As with any new idea that attracts the attention of policymakers, there is a need for researchers to maintain a critical awareness of the ways in which Responsible Innovation is publicly invoked. There is a danger that the term becomes a polite label for the status

quo. After all, who would argue against it? Who would wave a flag for Irresponsible Stagnation? If Responsible Innovation is to make a difference, there needs to be clarity about what it is and, crucially, what it isn't. Two chapters in this book explore the reality of "responsibility" (Chapter 7) and "innovation" (Chapter 1). Both notions are multi-dimensional. Responsibility is not synonymous with liability, and innovation looks less and less like a pipeline, if indeed it ever resembled one. Again, the picture that emerges should reassure innovators. Responsible innovation starts from an understanding of innovation as a system, a web of myriad actors, rather than a pipe. As Bessant describes, users are becoming increasingly assertive in innovation processes, so we must include them in the web along with scientists, entrepreneurs, governments and others. This complexity gives innovation the unpredictability that flummoxes Snow and others, but it suggests opportunities for previously closed conversations about innovation to include new perspectives and new questions. In computing, we see the rapid growth of particular innovations such as Facebook, driven by users, force new questions about privacy as the volume of available personal data explodes. If we turn, as Muniesa and Lenglet do in Chapter 10, to the world of finance, we can see that Responsible Innovation is made more complicated by the hybrid nature of financial innovations. But if the credit crisis has taught us anything, it is that efforts to govern complex systems should not be deterred by complexity.

There is a danger that any discussion of science and innovation policy gets bogged down in the technical intricacies of a particular area, be it finance, computing, geoengineering or nanotechnology. The chapters in this book suggest that, if we take a step back, to ask what responsible innovation might look like in general, the view we get can form the basis of a new approach to governance.

Preface

On April 1st 1956 the science fiction film Forbidden Planet went on general release. With echoes of Shakespeare's The Tempest, and featuring an innovative electronic music score and award-winning special effects, it is considered to be one of the greatest science fiction films of its time. The creative arts have always provided engaging ways to think about the promise and perils of science, technology and innovation, from Shelley's Frankenstein to Ridley Scott's Bladerunner. Forbidden Planet is no exception.

Set in the early twenty-third century, it opens with a United Planets cruiser approaching a distant planet called Altair IV, some 16 light years from Earth. The cruiser and its crew, captained by a young-looking Leslie Nielsen, have been dispatched to find out what has happened to a scientific expedition sent to Altair IV 20 years earlier. On approaching the planet the crackly voice of Dr Edward Morbius radios to warn them away and to turn back. He and his daughter are the lone survivors of the expedition, the others of which had been mysteriously killed by a dark and terrible planetary force, and he cannot guarantee the crew's safety. The crew land anyway, where they are astonished to be met by a highly advanced robot called Robby, 'tinkered together' by Morbius, which whisks them away to Morbius' residence, a home filled with a staggering array of technology the like of which they have never seen before. How did such wonders come about?

Morbius provides an explanation for this world of technological wonder. Taking them on a voyage deep within the planet he shows them a vast, intact citadel with 92 thermonuclear reactors, constructed by a long gone civilisation – the Krell. They had invented a machine – the "plastic educator"– which allowed the Krell to advance their intellectual capacity to unbelievable heights, to create 3D thought projections, materializing any object they could imagine: creation by mere thought. But all was not well on Altair IV. In advancing their intellect the Krell had also unwittingly heightened the dark forces of their subconscious – "monsters from the Id!", and on one night 200 000 years ago these forces overcame their civilisation, which was destroyed in a finale of brutal self-destruction. Morbius' use of the plastic educator had allowed him to create Robby, but now his own monsters were also being awoken, threatening the crew whom he feared would intrude on his world, taking him back to Earth . . . .

Well of course Forbidden Planet is science fiction: we are not the Krell and we do not inhabit a planet 16 light years from Earth. But even so, this story, the ending of which you will need to find out for yourself, illustrates some important features of science and innovation that are very real on our own planet. First, while science and innovation produce knowledge and value of many different kinds – in ways that can be radical and transformative – they also produce unanticipated impacts and unintended consequences. Our history is littered with the unintended consequences of innovations

past, from destruction of stratospheric ozone by chlorofluorocarbons, to birth defects associated with thalidomide and mesothelioma associated with asbestos inhalation, to the near collapse of the global financial system in 2008, in which the innovation of complex financial products, such as the 'toxic' collateralized debt obligations based on 'subprime' asset-backed securities, played no small part. These unplanned impacts can cut across borders, and across generations, reflecting what Hans Jonas called the 'altered nature of human action'[1] of late modernity. Science and innovation, as Ulrich Beck noted, co-produce risks with value, and such risks must be expected to occur, to varying degrees. Unexpected impacts might not have led us to the same fate as the Krell, but sometimes it feels as if we may be sailing rather close to the wind.

The impacts of science and innovation are often unpredictable, and always uncertain. How on earth (or rather Altair IV) could the Krell have predicted that an innovation like the plastic educator would conjure up "monsters from the Id" so powerful they would bring about the extinction of their race? Clearly this was not an intended outcome. Innovation, and the science this is sometimes based on, cannot be thought of as a simple, linear process where a brilliant idea translates into a set of predictable, and manageable, outcomes. It is messy, often involving many, where interactions, uses, and applications may or may not come about, with dead-ends and with impacts that can be diverse and complex in nature. Techno-science and innovation are as much social as technical phenomena. The impacts of the plastic educator on the Krell were a complex interplay of technology and psychology, involving what some might describe as the 'naturalization' of technology as it makes its uncertain and unpredictable way in society, Krell or our own.

Here, on our own planet, our penchant for liberal market economies (at least in recent times) initially allowed us to hope that an Adam Smith-like "Invisible Hand" would be sufficient to govern the 'products' of innovation and their impacts – which could be best managed by market forces. The progressive introduction of regulation in many spheres (notably after Rachel Carson's bleak description of the "Silent Spring" that widespread use of pesticides was causing on wildlife post World War II and the environmental protection regulation that subsequently evolved) have reflected our awareness of the limits of Hayekian thinking, and the need for governance beyond the market. Such regulation, which is sometimes required before authorization, marketing, and use in areas of innovation, such as pharmaceuticals and industrial chemicals, is a powerful and important codification of responsibility that accords with the norms and values of society – the values of a clean environment, protection of health, and so on.

But the decades since the 1950s have also shown the limits of regulation itself in the face of the unpredictability, uncertainty and ignorance associated with science and innovation. Put simply, regulation can be partially sighted, or blind, to that which it has not encountered before, to new things that inhabit its margins, or lie beyond. Things like geoengineering, or nanotechnology, or synthetic biology. Innovation is about creativity, often about doing things differently, in instances where there may be no rules, or the rules are fuzzy and partial. It was David Collingridge who alerted us to the dilemma this presents, one that surfaces often in debates concerning precaution: we can either wait for sufficient evidence to make the case for control (for example by bringing in new regulation or amending it) but risking what he described as 'technological lock-in' that

[1] For this and other references cited refer to Chapter 2, in which a full bibliography is given

is, that the innovation is so embedded in society that control may come at huge cost, and be resisted by vested interests. Or we can act earlier on, when there is far greater scope for control – but where evidence of undesirable impacts is poor, the case for control weaker, and the risk of lost benefits in the future great. In this case we may decide not to act, and hope not to be subjected to what Bernard Williams described as moral luck – that in the fullness of time we may still be held morally accountable for our actions. We can hope not to be subjected to the same fate as Frankenstein, facing the demon of our creativity as it approaches us across the glacier. Or we can try to do something else. But what might that be?

These issues get to the very heart of this book. At its core is a set of perspectives that addresses a couple of difficult, but important challenges. The first of these is how we can proceed (innovate, conduct science) responsibly under such conditions of unpredictability, uncertainty, and ignorance. It was the physical chemist, economist and philosopher, Michael Polanyi, 60 years ago, who asserted that '*you can kill or mutilate the advance of science, you cannot shape it*'. In his independent "Republic of Science" scientists had role responsibilities – to produce knowledge, to adhere to norms of professional conduct associated with data falsification, with plagiarism and so on. As Heather Douglas has so eloquently written, to reflect on wider moral considerations has had limited place in such role responsibilities, establishing a clear moral division of labour. Douglas herself acknowledges the generalization inherent in this statement, quoting notable instances, such as the angst and actions of early nuclear physicists, who were concerned as much with the dangers as the wonders of their science. Indeed, most scientists and innovators would not wish to neglect their wider moral responsibilities, and many wish to see a better world as a result of their creativity. Many will understand the problems inherent within the independent Republic of Science, the Invisible Hand and regulation, and find the alternative position of succumbing to time, the risks of lock-in and moral luck unsettling and ethically problematic.

But this understanding is of only limited use if we cannot present a way forward, making clear (or at least beginning a conversation about) what "innovating responsibly" means, what it might involve, and how it might differ from what has come before. This is the aim of this book. It seeks to describe how we might conduct science and innovation responsibly under conditions of uncertainty and ignorance, collectively enlarging our role responsibilities to include a greater moral dimension, to those living now, those yet to be born, and those beyond our own species. This is not an easy feat. We cannot predict the future, but we can do our best to anticipate, to reflect, and deliberate on the future we are creating as this unfolds, to collectively steward this to acceptable and desirable ends in a way that is democratic, equitable and sustainable. The emphasis here is on the word 'we': this is a collective responsibility, reflecting the collective nature of science and innovation itself, where irresponsibility is a product not of the individual, but the system.

In order to tackle this there is a requirement to understand what responsibility means, particularly in the context of science and innovation as future-oriented activities with uncertain impacts. There is a need to consider the responsible in responsible innovation. Various chapters in the book, and notably the contribution by Chris Groves and Alexei Grinbaum, tackle the ambiguous term 'responsibility'. Here, you will be reminded of responsibility as accountability, answerability and liability, as consequentialism – and the problems these present for innovation, for reasons we have described above. Other

framings of responsibility that are future-oriented in nature, and that accommodate uncertainty and values – dimensions of care and responsiveness – then become important. As Henry Richardson has written, those of us who are parents, or who have responsibilities for others in similar ways, will be very familiar with these dimensions. We understand that when acting responsibly, we cannot predetermine the lives, lovers, careers and crimes of our children, but we can instil in them values on which we hope they will conduct their lives, and then respond as they grow and change in the face of uncertainty and a changing world. When we think about responsibility in these sorts of ways, it starts to become easier to understand how to innovate responsibly.

This introduces an equally important challenge for responsible innovation, one that goes beyond understanding and managing unintended consequences. This challenge is about what we *do* want science and innovation to do, as much as what we want them *not to do*. What values do we want science and innovation to be anchored in, how can these values be democratically defined, and how can the inevitable tensions and dilemmas (e.g. between innovation for economic growth and environmental sustainability) be negotiated, and resolved. This is no longer just a question of the governance of unintended consequences, but one of the governance of intent, one that is about the very purposes, motivations and visions of scientists, innovators and those who fund them. These have been key considerations for ethically-problematic areas such as genetic modification and geoengineering, where the framing of intent and motivation becomes key. And yet current modes of research and innovation governance allow little scope for reflection on purposes and motivations, beyond narrowly configured ethical approval for research involving animals and people. The reader will find chapters in the book that discuss concepts of values-sensitive design, of the quest for the 'right impacts' of research and innovation. This is an important departure point for responsible innovation, challenging us to ask what kind of future we want from science and innovation, and the values this is based on. It will highlight an essentially political dimension to responsible innovation. And it will present responsible innovation not as a burden in which loss of freedom and the inhibition of creativity is a casualty, but as an opportunity to identify targets for science and innovation to create value in ways that are socially desirable. It would be easy for responsible innovation to become another form of ethical review, or a bureaucratic hurdle that is required but not valued. This is not the ambition of the authors of the chapters of this book. A broader reconfiguration, one that creates opportunity for innovation toward socially desirable ends, as well as opportunities for timely management, is needed. A reconfiguration that is values- and not rules-based, that is flexible in the face of uncertainty, and that allows us to take collective responsibility for a future which science and innovation play such critical roles in shaping.

The book is laid out in the following way: after setting the scene regarding the contemporary innovation landscape and its management in the first chapter, subsequent chapters in the book present a vision and framework for responsible innovation, including the call to embed integrated and iterative processes of individual and collective reflection, anticipation and broad deliberation in and around the science and innovation process itself, to include both its products (intended or otherwise) and purposes. This, as Andy Stirling has described, is a process of opening up, of inviting in, of encouraging debate and even contestation, understanding that the wider social context of science and innovation cannot be understood by personal reflection alone. Various elements of a proposed responsible

innovation approach are then outlined in more detail, around, for example, the dimensions of anticipation, and opening up dialogue and debate; and the concept of responsibility itself is presented for philosophical analysis. Such dimensions have a rich history in the literature, including anticipatory governance, technology assessment in its various forms, upstream engagement and socio-technical integration. It is the further dimension of responsiveness that becomes important here – how we develop ways to respond at various scales (personally, institutionally, politically) to ensure innovation itself can look different in response. Chapters on dynamics of responsible innovation, governance and regulation develop further thinking on these themes. The book concludes with an important set of chapters that consider the emerging concepts of responsible innovation in important areas of contemporary science and innovation; in finance, in geoengineering, information technologies and nanotechnology.

Scholars will recognise important parallels and cognates, from the work of von Hippel to Callon, Jonas and many others, extending perhaps as far back as Francis Bacon. These provide important foundations for responsible innovation that should not be ignored, and from which the concept rightly will evolve. It is very important to note that this book does not purport to be a definitive guide to responsible innovation. Such hubris is both premature and may serve to lock-in the term itself at a time when study and open debate are what is needed. The book instead offers a set of perspectives in an evolving field that many are trying to make sense of and to understand in terms of motivation. It was Heraclitus who reminded us that we never step in the same river twice. Let us hope that many will have the opportunity to dip their toes.

The impetus for this book was an international workshop on Responsible Innovation[2] held at the Residence of the French Ambassador in London in May 2011, and funded by the Science and Technology department of the Embassy: many of the contributing authors attended this event. We are indebted to the French Embassy, without which this workshop, and consequently this book, would not have been possible. Our particular thanks go to Serge Plattard and intern Pauline Gandré. We would also like to thank the UK Engineering and Physical Sciences Research Council (and in particular Peter Ferris, Atti Emecz, Alison Wall, Nicola Goldberg and Nick Cook), and the Economic and Social Research Council (and in particular Andy Gibbs) and the UK Foreign and Commonwealth Office (and in particular Fabien Deswartes and Mark Sinclair of the Science and Innovation team) for their support. R.O. would also like to thank Michael Depledge, Geoff Petts and members of the sadly missed Royal Commission on Environmental Pollution for their support.

We dedicate this book to future generations who will, we hope, most benefit from it.

Richard Owen
John Bessant
Maggy Heintz
December 2012

[2] http://www.ambafrance-uk.org/Franco-British-workshop-on,18791

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1

Innovation in the Twenty-First Century

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1.1 Introduction

> *It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change*
>
> (Charles Darwin)

Darwin was right. His famous comment underlines one of the key challenges facing organizations – unless they are prepared to change what they offer the world and the ways they create and deliver those offerings they could be in trouble. The challenge is not whether or not to innovate, but *how?* This makes building the capability to deliver a steady stream of innovation a strategic imperative, not just for commercial organizations, but for any enterprise dealing with the turbulent conditions of the early twenty-first century. Public services struggling to balance rising demand and expectations of high quality delivery against the rising costs of provision need to seek new ways of meeting social needs. Third sector organizations concerned with improving social conditions recognize the importance of thinking and working in new directions if they are to gain attention and acquire the resources they need to carry through their agenda.

Innovation is about change and this can take place along a spectrum of increasing novelty, from simple incremental improvements – "doing what we do, but better" – through to radical, new to the world changes. The risks involved vary, as do the benefits,but it is clear that even sustaining growth through incremental innovation is not going to happen by accident. Any organization might get lucky once but in order to be

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able to repeat the trick there is a need for some kind of organized, structured approach to managing the process. This needs to find answers to two key questions:

- *Where* can we innovate?

and

- *How* can we innovate?

The trouble is that innovation involves trying to hit a moving target. Environments constantly shift and pose new threats – new technologies appear, new markets emerge, the regulatory framework changes – and unless organizations have the capacity to innovate their approaches to innovation they may not survive in the long term. History is clear about this – very few organizations are long-term survivors and those which have managed to stick around for over 100 years have made some major changes to what they do and how they do it (Francis *et al*., 2003).

Sometimes the changes are pretty dramatic, challenging the roots of where the company began and overturning a lot in the process. TUI, for example, is the largest European travel and tourism services company, owning (amongst others) Thomson Holidays, Britannia Airways, and Lunn Poly travel agents. Its origins, however, go back to 1917 where it began as the Prussian state-owned lead mining and smelting company! Nokia's key role as a leader in mobile telephony hides its origins as a diverse timber products conglomerate with interests as wide as rubber boots and toilet paper! One of the oldest companies in the world is the Stora company in Sweden, which was founded in the twelfth century as a timber cutting and processing operation. It is still thriving today – albeit in the very different areas of food processing and electronics.

A key dimension when exploring innovation lies in the concept of responsibility. Clearly, not all innovations are necessarily good things. Others may start out offering positive benefits, but later turn out to have unintended negative consequences. The famous example of DDT is a case in point – originally hailed as a breakthrough innovation in the field of pesticides it later turned out to have significant negative impacts. Other examples include the pharmaceutical thalidomide, nuclear power, and chlorofluorocarbons (CFCs) used as refrigerants and propellants.

The key issue is around how far we explore and consider innovation in its early stages in terms of the potential impacts it might have, and how far we are able and prepared to modify, ameliorate, or possibly abandon, projects which have the potential for negative effects – what Owen *et al*. (Chapter 2) describe as the dimension of responsiveness. It is this dimension and others (anticipation, reflection, and deliberation) which together underpin the concept of responsible innovation. The ways in which this can be conceptualized and operationalized in the face of uncertainty form the core theme of this book. Interestingly, much of the academic and policy-oriented innovation research tradition evolved around such concerns, riding on the back of the science and society movement in the 1970s. This led to key institutes (like the Science Policy Research unit at Sussex University) being established (Cole *et al*., 1973). While a sophisticated toolkit of approaches and resources emerged from much of this pioneering work, its use has often been limited and considerations of "responsible innovation" have often been marginalized in strategic management thinking (although there have been some high profile exceptions, such as the long-running debate around genetically modified food – see Von Schomberg (Chapter 3).

The key themes and content of responsible innovation will be explored in detail in later chapters in this book. The purpose of this chapter is to look at how the twenty-first century environment is changing and the challenges this poses for innovating organizations: important context for the discussions of responsible innovation that follow. In the face of some radical technological, market, social, and political shifts, how should they be thinking in terms of adapting and configuring their innovation processes? What are the strategic options open to them and how could they best explore the innovation space? Of the bundle of learned behavior patterns which they make use of, which ones should they be doing more of, reinforcing and strengthening? Which ones should they be doing less of, or even stopping – things which worked in the past but may no longer be suitable approaches? And which new behaviors are they going to need to learn and practice to take advantage of the newly – emerging context in which they are operating?

Before we move to the challenges it is worth spending a little time looking at two core questions around where and how organizations could innovate.

1.2 How Can We Innovate? – Innovation as a Process

Unlike the cartoon image, innovation requires a little more than just a light-bulb moment as an idea flashes above someone's head. In reality it involves a journey, growing and shaping the original trigger idea into something which can spread across a population and create value. As Figure 1.1 shows, traveling along this road means finding answers to some key questions:

No organization starts with a perfect model of the innovation process. Instead it is something they build up through a learning process, trying out new behaviors and hanging on to those which work. Eventually these patterns of repeated and learned behaviors – "routines" – become embedded in "the way we do things around here" and take shape in the form of policies, procedures, and rules (Nelson and Winter, 1982; Zollo and Winter, 2002). They will vary between organizations – everyone finds their

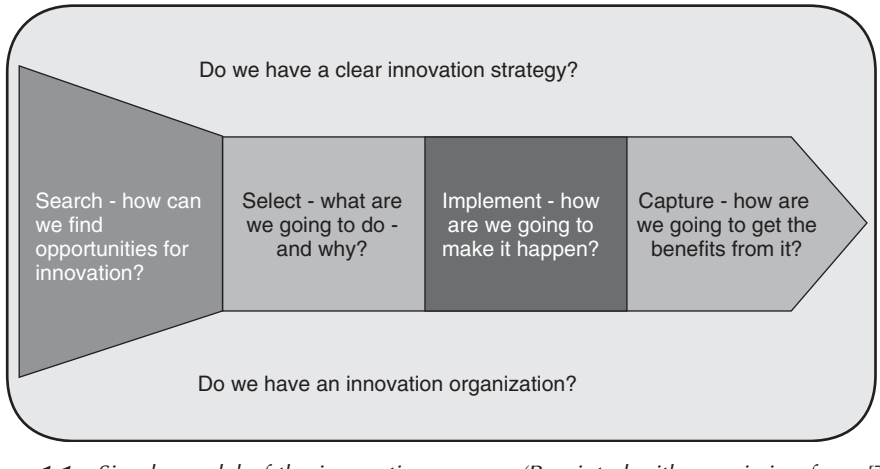

Figure 1.1 *Simple model of the innovation process (Reprinted with permission from [Tidd and Bessant, 2009] Copyright (2009) John Wiley & Sons Ltd)*

own particular way of answering the basic questions and some recipes work better than others. This is useful, since it allows us to learn not only through experience but also by watching how others manage the innovation task and grafting on useful new approaches and ideas.

However, we should also recognize that learning to manage innovation is not just a matter of building capability to deal with the questions of searching, selecting, implementing, and so on. Environments are unpredictable and complex, so we don't know what will emerge in the way of new threats or opportunities. So the key to long-term innovation management success is to build "dynamic capability" – to be able to step back and review our innovation process and reconfigure it on a continuing basis (Teece *et al*., 1997). This is as much about letting go of old routines as it is about developing new ones.

1.3 Where Could We Innovate? – Innovation Strategy

Innovation can take many different forms – as Figure 1.2 suggests, there is plenty of space to explore (Francis and Bessant, 2005). We can think of four core dimensions:

- "product innovation" – changes in the things (products/services) which an organization offers;

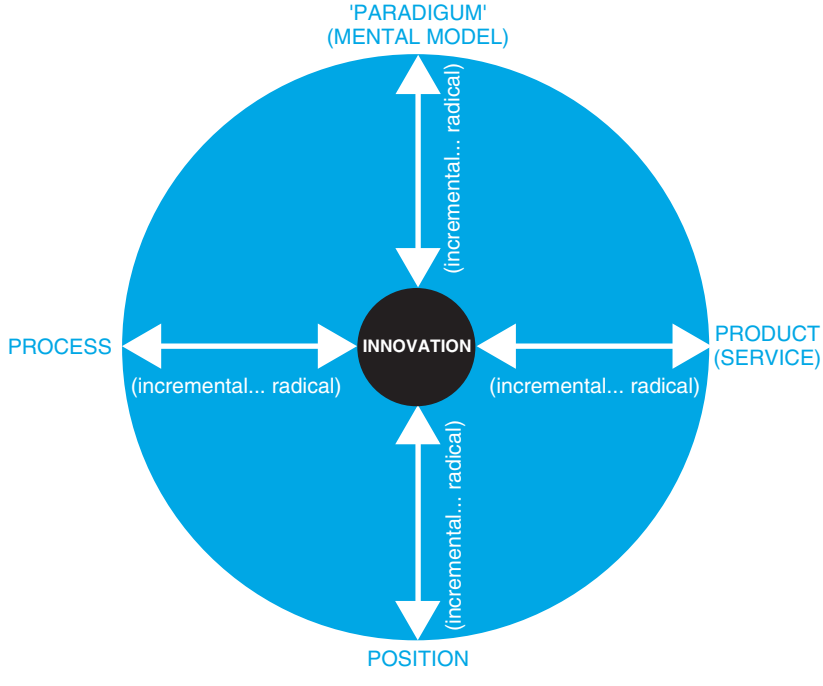

Figure 1.2 *Exploring the innovation space (Reprinted with permission from [Tidd and Bessant, 2009] Copyright (2009) John Wiley & Sons Ltd)*