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Global Governance of Science

Report of the Expert Group on Global Governance of Science to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission

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Report of the Expert Group on Global Governance of Science to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission

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2009

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SCIENCE, ECONOMY AND SOCIETY

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Foreword

I am very pleased to present the Expert group report on the Global Governance of Science to which legal scholars, sociologists, philosophers and political scientists from Europe, the United States of America, China and South-Africa have contributed.

Science is a major driving force of globalisation. The internationalisation of the European Union's Framework Programme for Research and the accompanying challenges to address specific global aspects of The European Research Area, such as scientific misconduct, the possible emergence of 'ethics-free' zone and intransparent forms of mandated science at the global level have led me to establish this Expert Group to advise the European Commission.

I can fully agree with the expert group's approach to the matter by which they advocate a vision of global governance for the common good that invokes European principles of good governance and fundamental rights.

Jean-Michel Baer

Director Science, Economy and Society Directorate,

Directorate-General for Research

European Commission

Executive Summary

As a result of the Lisbon strategy adopted by the European Council and creation of the European Research Area (ERA) in 2000, science has become a central component of European policy discussions. The expert group affirmed this significance, arguing that it extends beyond Europe as the geography of science around the world changes. Indeed, it is our belief that as a political entity situated between national and global levels, with its principles of good governance, charter of fundamental rights and commitments to a European Research Area, the European Union is ideally placed to encourage critical reflection and undertake practical leadership in relation to the global governance of science and innovation.

Chapter one adopts a working definition of science, introduces issues of governance and the complexities of global governance and provides some historical background on the emergence of contemporary assumptions in and approaches to science policy. We take science to be a social institution producing knowledge oriented towards action. Science is becoming more important to the health and wealth of nations, and has attracted growing public funding. But such investments call for global governance in two senses of the word 'global': The governance of science needs to focus on the whole spectrum of scientific activity, from theory construction and basic research to technological development and innovation. Governance also needs to occur at levels above and beneath national political entities and their international extensions. The received linear model of science policy, in which investments are turned over to national scientific communities for autonomous utilization and/or market allocation, is no longer adequate.

The idea of global governance highlights the decreased salience of nation states and growing importance of non-governmental organizations and actors in all functions of governance, from setting goals and norms, selecting means, regulating their operations and verifying results. This is particularly relevant to science, which is governed internally by members of the society of science and externally through interactions with the society around it. It is also a concept that gives moral ideals and ethical reflection more prominent roles in governance than has customarily been the case.

Chapter two focuses on the society of science, considering initially how the practices of science (understood broadly to include medicine and engineering) aim to ensure quality, integrity and openness. Scientists commonly see themselves as bottom-up contributors to a social institution whose fruitful creativity is compromised by attempts at top-down external control. Additionally, the society of science is inherently international, making external governance even more problematic. But the barriers to governance in some strict sense need not preclude and may even require governance in a broader sense, including general guidance and public participation.

Critical reflection on the internal self-governance by the society of science reveals strengths and weaknesses. Internal governance has been remarkably successful in producing knowledge that builds capacities for action. But not all such capacities have been equally beneficial and self-interest sometimes contaminates self-governance. Science-based innovations as well as unintended consequences from scientifically facilitated actions have challenged cultural traditions. At least since the end of

World War II, even as scientists have been ever more effective in contributing to healthcare, economic development and military security, concerns have grown about instances of fraud, misconduct, and questionable research practices. Although self-governance deserves respect, especially in the light of the European governance principles of proportionality and subsidiarity, practical limitations point towards a need to move from an emphasis on eradicating 'bad science' to rethinking and fostering 'good science.'

Chapter three turns to science in society in order to place the governance of science in a social context of changing public relationships and new geographies. It charts the rise of public participation and deliberative models of governance and asks how such models might be scaled up to the global level. As the power of science grows, and more science takes place in more places around the planet, harnessing its benefits and innovative applications while mitigating its challenges has become a key question for sustainable globalisation. This again requires attention to ethics as an aspect of governance and explores the challenges of engaging with moral questions across different social contexts. Global governance must acknowledge tensions between universal scientific knowledge and general ethical principles, on the one hand, and local knowledge and traditional values, on the other. Extending ethical governance to the global level, global governance needs to find new ways deal with scientific and technological divides between rich and poor countries.

As articulated in a concluding chapter four, we seek to advance a vision of global governance for the common good that invokes European principles of good governance and fundamental rights. Global self-governance within science is to be affirmed, but self-governance is not enough. The society of science is ultimately responsible to the good of the larger society in which it exists. In a globalised world, this means that we must find ways to globally govern science that seek mutual respect, dialogue and reconciliation.

Assumptions about the means and ends of science currently reinforce governance systems that are in many instances defined by national boundaries. Science and innovation are currently limited by policies of 'techno-nationalism' or transnational corporate economic interests. Given that the biggest problems demand both scientific input and international collaboration, global governance has become unavoidable. At the same time, we must consider how the scientific community, which is itself an increasingly globalised network of bottom-up collaboration, can contribute to good governance. As we think globally, we need to recognise also that the world is far from homogenous or flat. Local differences, local values and local knowledge matter. The global governance of science therefore sharpens the argument for greater local participation in matters of science and science policy, particularly in relation to issues of ethics. The challenge is to develop new forms of engagement that allow for genuine exchange of knowledge and values, within science and between scientists and the larger societies within which they ultimately exist.

Our recommendations are addressed not only to policymakers in the European Commission and member states, but equally to those organisations worldwide that sit within and around science. Our recommendations might most easily be interpreted in the context of publicly-funded academic science. But we believe that they apply as well to the increasingly greater proportion of science and scientists within the private sector.

Recommendations

1. Within the society of science, practices of ethical governance should be promoted – by, e.g., grant activity requirements, educational programmes, research projects and related conferences or other appropriate means.

2. Members of the society of science should be encouraged to become self-critical – by, e.g., required collaboration with complementary disciplines and non-scientists in order to better recognize the ways they are influenced by larger social contexts.

3. All scientists should be required to make the results of their research as widely available as possible – by adoption of open access publication protocols.

4. All ERA research projects, including collaborations with scientists in other countries, should seek ways to enact basic fundamental rights of dignity, freedom, equality, solidarity, citizens' rights, and justice in ways that also seek to respect and learn from the social and cultural contexts of non-Europeans – by, e.g., expert and public deliberations that develop and apply ideals of reconciliation.

5. ERA research should be developed to promote critical reflection and discussion with regard to both the means and ends of science – by means, e.g., of selective research projects and public activities that require interdisciplinary collaboration and citizen participation, including reflection of the ways in which the principles of European governance and basic fundamental rights serve as appropriate and applicable guidelines for the practice of science.

6. The European Union should seek to extend to the global level its leadership in working to harmonize the internal and external governance of science across national borders – by furthering research and discussion on the global governance of science and seeking to develop appropriate protocols and their application for global collaboration.

We commend the Governance and Ethics Unit of the Science, Economy, and Society Directorate for initiating this exploration of issues related to the global governance of science and recommend that further and more extensive research be promoted on this topic.

Chapter 1. Introduction: Aspects of Science and Governance

Science has been variously defined and continuously debated ([1]). For the purposes of this report, science is broadly conceived as a special kind of knowledge along with a distinctive set of practices and cultures for producing it. In accordance with Francis Bacon's famous dictum that 'knowledge is power,' we can see scientific knowledge as constituting *a capacity to act* ([2]). Modern scientific knowledge is not simply an understanding of the world, but an understanding that enables people to intervene in and alter that world – thus manifesting an orientation towards technology and innovation. Science is also a human activity enacted through distinctive social institutions, professional organizations, government agencies, schools, universities and private firms. In a world in which to be called 'scientific' carries with it significant social prestige, the precise definitions of what counts as science are thus hotly debated. As this introduction briefly explores, to talk about the governance of science therefore raises multiple questions related to both the processes of science and its products.

For present purposes it is not necessary to offer a rigid definition of science as product or as practice. We accept that, to some extent, science is what scientists do. The boundaries of science can be taken as those used by the scientific community itself. However, our view of science does take us beyond a simplistic notion that it exists merely to understand the world. Rather, it is intertwined with technology, innovation, and socio-economic change, facilitating the creation of new possibilities. It is this aspect – the role that science plays in creating new futures – that raises the most pressing questions for governance. Indeed, we see the boundary between science and technology as less and less clear, so that our analysis encroaches upon activities that might otherwise be described more broadly as innovation. Finally, it is important to note that our working definition of science encompasses as well engineering, medicine and the social sciences.

Governance in accordance with good principles

Governance encompasses the multiple processes of control and management that take place within and between states, in public agencies and private firms, or in any other social organization ([3]). Governance involves directing or setting goals, selecting means, regulating their operation, and verifying results.

This is a view confirmed in a white paper on *European Governance*, for which 'Governance means rules, processes and behaviour that affect the way in which powers are exercised at the European level, particularly as regards openness, participation, accountability, effectiveness and cohesion.'

1 See, e.g., A.F. Chalmers, *What Is This Thing Called Science?* 3rd edition (Indianapolis, IN: Hackett, 1999); and Leslie Stevenson and Henry Byerly, *The Many Faces of Science: An Introduction to Scientists, Values, and Society* (Boulder, CO: Westview Press, 2000).

2 Nico Stehr, *Knowledge Politics: Governing the Consequences of Science and Technology* (Boulder, CO: Paradigm Publishers, 2005).

3 Anne Mette Kjaer, *Governance* (Cambridge, UK: Polity Press, 2004). See also Carolyn J. Heinrich and Lawrence E. Lynn, eds., *Governance and Performance: New Perspectives* (Washington, DC: Georgetown University Press, 2000).

Governance thus involves a conscious decision not to rely simply on power politics or markets, although it may well include either or both. In democratic, pluralistic societies it will involve action by multiple intermediate voluntary associations, from churches to labour unions and cultural organizations. And good governance will seek to enact precisely these five principles:

- *openness*, communicating accessibly with the public;
- *participation* by citizens as much as possible in all policy formation;
- *accountability* clearly apportioned among EU institutions;
- *effectiveness* in achieving goals and objectives;
- *coherence* among institutions and policies.

The application of these five principles, the white paper further notes, promotes those of:

- *proportionality*,
- *subsidiarity*,

which are also foundational to European Union governance.

The implication of these principles for the good governance of science may not always be straightforward but should remain a theme for reflective examination. In this regard, our report may pose as many questions as it presents answers. But these questions are vital, and our hope is that they set the agenda for an important debate that will determine a robust approach to the global governance of science.

Governing globally

Science has an ambivalent relationship with traditional national politics and policy. On the one hand, scientists seek recognition and financial support from governments; on the other, the same scientists can resist governmental control. Governments likewise are ambivalent: they aspire to have their decisions legitimated by science, but try to shape science according to their own interests.

In relation to science, governance can be seen as concerned with providing, distributing, and regulating. Governance provides funds to support some kinds of science over other kinds, and distributes the results of science to some constituencies at the expense of others. Yet the most obvious and contentious form of governance involves regulation, the class of activities concerned with preventing, allowing, steering and confirming a flow of events. The web of activities and policies that support, distribute, and regulate scientific processes and products make up systems of governance. At the national level, these are fairly familiar, from funding agencies to educational institutions and regulatory bodies, but in a global context things become more complex.

Governance can be 'global' in two senses. First, 'global' can mean comprehensive, applying to all of science. Second, 'global' can indicate a crossing of national boundaries. To talk about 'global governance' in the context of international relations emphasizes the second sense. Global governance is concerned with problems that involve multiple countries. Yet as a technical term 'global governance' is distinguished from *international* governance. As one United Nations publication explains:

> *"In contrast to international governance, global governance is characterized by the decreased salience of states and the increased involvement of non-state actors in norm- and rule-setting processes and compliance monitoring. In addition, global governance is equated with multilevel governance, meaning that governance takes place not only at the national and the international level… but also at the subnational, regional, and local levels. Whereas, in international governance, the addressees and the makers of norms and rules are states and other*

intergovernmental institutions, non-state actors… are both the addressees and the makers of norms and rules in global governance (4).”

So global governance is about more than relationships between states. It also focuses on the growing complexity of trans-state relationships. In our report, the term ‘global governance’ functions in this way, although it is recognised that in order for governance to be truly global in the transnational sense it must in addition be global in the sense of being comprehensive.

The governance of science is faced with the challenge of rapidly-advancing possibilities realized through research. Across borders, the societal contexts within which new knowledge is generated, distributed and regulated will vary hugely. Science nevertheless remains a non-state and transnational social institution, so that its governance is necessarily global, both internally and externally.

The new geography of science

For much of the 20th century, scientific activity was concentrated in a small set of countries. Since the last decade of the century, science and innovation have become increasingly and genuinely global. Although more science is now being done by more people in more places, forcing policymakers to expand their horizons, the distribution of growth remains quite uneven. In 2000, the European Union looked to the United States to assess its innovation performance. Since 2000, China, India and other countries have become common points of reference. Their growth in science and innovation activity introduces new needs and challenges for global governance.

China, for instance, has begun the most ambitious science funding programme since the United States undertook in the 1960s its race to the moon. The Chinese government has set a target for investment in research and development at 87 billion euros by 2020, and is rapidly building capacity in areas of science that were previously the preserve of the United States, Europe and Japan. Increasing money is also leading to increasing numbers of scientists. China will add to its already formidable base of science and engineering graduates (4.9 million in 2004), and will continue to attract a diaspora of scientists back from studies and posts abroad.

In India, the picture is more complicated, but the figures are still impressive: 8% economic growth since 2003 and a doubling in the number of patents since 2000. Over a twenty-year period from the late 1980s to the early 2000s, Indian investment in biotechnology has almost quadrupled (5).

The rise of world class science in new places with incompletely-understood cultures and practices raises enormous challenges for governance, both in these countries themselves and in the global community. In addition, this is true for scientists themselves and for those non-scientists who are in the process of creating an international civil society.

Governing inside and out

Governance can be internal or external to institutions. Within science, scientists themselves govern the production of knowledge in myriad ways (6).

4 Volker Rittberger, ed., *Global Governance and the United Nations System* (New York: United Nations University Press, 2001), p. 2.

5 James Wilsdon and James Keeley, *China – The Next Science Superpower* (London Demos, 2007); Kirsten Bound, *India – The Uneven innovator* (London, Demos, 2007); and James Wilsdon and Charles Leadbeater, *The Atlas of Ideas* (London, Demos, 2007).

6 These ways have been classically articulated by sociologist Robert K. Merton in ‘*Science and the Social Order*’ (1938) and ‘*The Normative Structure of Science*’ (1942), both included in *The Sociology of Science: Theoretical and Empirical Investigations*, ed. Norman W. Storer (Chicago: University of Chicago Press, 1973), pp. 254-285.

They regulate the production of knowledge by, for example, structured experimentation, systematic model construction, simulation and other methods. They control what counts as knowledge, through peer review and replication. And they manage how science is communicated by means of conference presentations and professional publications. In addition, scientists heavily influence processes of research funding through peer review and grant panels, and they guide decisions about the hiring and promotion of fellow scientists.

Such internal governance activities are different from the external governance of science by non-scientists. External governance seeks to provide, regulate, and distribute science by:

1. Upstream funding of some types of research in over others thus channelling scientific research in specific directions;

2. Establishing rules and enforcing standards for people and organizations;

3. Attaching certain attributes, such as property rights, to scientific knowledge and the products of innovation;

4. Downstream regulation or restricting what are considered the misapplications and misuses of new science and technology;

5. Educating the public and encouraging debate about the products and processes of science.

Such efforts originate *outside* the scientific community. But the specialised nature of science means that many scientists are also intimately involved with these forms of external governance. As well as citizens and researchers, they may act as experts, specialists, communicators, teachers, regulators and strategic leaders.

Tensions between external and internal governance can lead to conflicts. Scientists may often be critical of external governance, insofar as it limits autonomy and demonstrates subordination to the public good – placing 'science on tap, not on top,' in Winston Churchill's phrase. The political governance of science asserts society's control of science, technology, innovation and the future. But as the authority of science grows, so does the risk that it becomes politicized, shaping and constraining political action or justifying inaction. As we consider the social control of science, we also need to bear in mind the power that science can have in and over society.

Despite the language of social *control*, however, the governance of science is not inherently prohibitive. Good democratic governance opens up options and opportunities for the social use of new knowledge, rather than just closing options down through regulation. Civil society is not simply interested in limiting scientific activity, but in steering the production and use of knowledge to appropriate ends, be it in relation to healthcare, education, the environment, or any number of sectors within and across nations.

Many science policies are underpinned by what has come to be termed the *linear* or *instrumental* model – tracing a line from science, through technological application, to social benefits. As formulated most influentially by U.S. President Franklin D. Roosevelt's science adviser, Vannevar Bush, the linear model argues that the government should provide scientists with resources and then allow scientists themselves to determine how best to utilize the resources with as little state interference as possible ([7]). Such a simple governance regime

7 Vannevar Bush, *Science: The Endless Frontier* (Washington, DC: U.S. Government Printing Office, 1945).

gives scientists significant public support and autonomy which, it is believed, will produce knowledge that can be exploited for technical and social progress. Despite being revealed by social scientists and philosophers as self-serving and empirically dubious ([8]), the model nevertheless remains extremely influential as a default position in science policy discussions.

The limits of governance

Contemporary governance approaches, whether or not they explicitly critique the linear model, no longer assume that the potential benefits of science emerge unproblematically. It is increasingly common to prioritise scientific areas, direct technological development and boost innovation, as well as regulate its activity. But as more and more organisations actively pursue governance agendas within and around science, we should be realistic about the limits of various approaches.

The influence and persistence of regulatory regimes, once established, is important, but should not be over-estimated. An analysis of the governance of scientific knowledge in the contemporary world reveals the practical incompleteness, fragility, obsolescence and often failure of attempts to govern science.

In addition, the tempo of science can undermine efforts at governance. The speed of scientific and technological innovation often leaves governments and the public reacting to events rather than responsibly governing new possibilities. Regulatory regimes can be quickly surpassed by new knowledge or invention. Indeed, scientists themselves are not always able to identify the future opportunities and challenges presented by new scientific knowledge production, even if they may seem to be the only ones with the expertise required to anticipate them.

As is the case with politics and policy generally, the governance of science will vary across political systems. Forms of governance are not inevitable, and vary from place to place and time to time. Although the governance of science has a strong universal moral dimension, science policy will be interwoven with different cultural, economic and historical traditions, institutional designs and legal arrangements. Governance is built on relationships between power and science, between nation and transnational organizations, between state and civil society, that will vary significantly among nations.

Social contexts and social contracts

Over the last century, aspects of the governance of science have attracted growing public interest. The distinctively modern social context is constituted by what is often termed a 'social contract' for science. As already noted, this is typically based in the linear model in which science is left to its own devices in the belief that it will then straightforwardly deliver social benefits. But this is a moribund social contract ([9]). A combination of internal reflection among scientists and external actions by civil society and states are reshaping the governance landscape ([10]).

8 See, e.g., Daniel Lee Kleinman, *Politics on the Endless Frontier: Postwar Research Policy in the United States* (Durham, NC: Duke University Press, 1995); and John Ziman, *Real Science: What It Is and What It Means* (Cambridge: Cambridge University Press, 2000).

9 Radford Byerly Jr. and Roger A. Pielke Jr., '*The Changing Ecology of United States Science,*' *Science*, vol. 269 (15 Sept. 1995), pp. 1531-1532; and Jane Lubchenco, '*Entering the Century of the Environment: A New Social Contract for Science,*' *Science*, vol. 279 (23 January 1998), pp. 491-497.

10 David H. Guston, *Between Politics and Science: Assuring the Integrity and Productivity of Research* (New York: Cambridge University Press, 2000).

In large measure this can be associated with a trajectory of public unease traceable back as far as World War I. During much of the 19th century, science progressed with little if any conscious attention to issues of internal or external governance. Operating independently, the scientific community appeared to produce new knowledge in physics, chemistry, geology and biology in ways that readily led to new understandings of the world and contributed to the health and wealth of nations. The linear model seemed to reflect reality. World War I demonstrated, however, the degree to which science and innovation could be marshalled for destructive purposes – a revelation to which World War II gave even more dramatic expression in Nazi industrialized death camps and the atomic bombings of Hiroshima and Nagasaki.

In response, the governance of science gradually became a global, public issue. In the case of medical experimentation, the medical community worked to both influence and internalize public concerns through the application of informed consent in research ([11]). The path from the Nuremberg Code (1947) to the Declaration of Helsinki (originally 1964, with multiple revisions since) is illustrative. In response to threats from nuclear weapons, scientists and engineers themselves began to question the way such devices were produced and deployed. The Einstein-Russell manifesto of 1955, for instance, called on scientists to become involved in public affairs in order to educate the public about the dangers of nuclear warfare ([12]).

During this same period, a cadre of biologists and environmental scientists were becoming increasingly concerned about levels of new chemical flows into the natural environment. A pivotal expression of this concern was Silent Spring by field biologist Rachel Carson ([13]), which stimulated the emergence of an environmental movement and led to the establishment of state agencies to protect the environment. Environmental research and regulation thus joined food and drug regulation as a major area of science and governance interaction.

Beginning in the 1970s a series of high profile technological catastrophes, airline crashes, oil spills, the chemical plant explosion in Bhopal, India, and the disaster at Chernobyl, shook public confidence in technological manifestations of scientific knowledge and the ability of science to assess and manage risk ([14]). In the life sciences, research began to raise hard questions for bioethics. In one instance, a group of scientists called for a temporary moratorium on recombinant DNA research ([15]). Others discussed the more general possibility of setting "limits of scientific inquiry ([16])". An existing social contract for science began to be questioned as a result of the evolving social context.

During the 1990s, concerns intensified about genetic engineering in food, animals and potentially humans. The 1966 cloning of Dolly the sheep kick-started a public reaction against the potential cloning of human beings. Even the evolutionary biologist Edward O. Wilson, struggling with the

11 Paul Weidling, '*The Origins of Informed Consent: The International Scientific Commission Medical War Crimes, and the Nuremberg Code*,' Bulletin of the History of Medicine, vol. 75, no. 1 (2001), pp. 37-71.

12 See, e.g., Morton Grodzins and Eugene Rabinowitch, eds., The Atomic Age: Scientists in National and World Affairs; Articles from the Bulletin of the Atomic Scientists, 1945-1962 (New York: Basic Books, 1963).

13 Rachel Carson, Silent Spring (Boston: Houghton Mifflin, 1962).

14 See, e.g., Charles Perrow, Normal Accidents: Living with High-Risk Technologies (New York: Basic Books, 1984).

15 Clifford Grobstein, *A Double Image of the Double Helix: The Recombinant DNA Debate* (San Francisco: Freeman, 1979).

16 Gerald Holton and Robert S. and Morison, eds., *Limits of Scientific Inquiry*, theme issue, *Daedalus*, vol. 107, no. 2 (Spring 1978).

prospects of biodiversity destruction and volitional evolution, argued the need for 'science and technology [to be] tempered by ethics and politics' ([17]). Leon Kass expressed an even more provocative criticism by defending the 'wisdom of repugnance' ([18]) and producing a President's Council on Bioethics report that criticized programs for use of drugs, bioengineering, and genetics for human enhancement in performance and life extension ([19]). Such issues continue to reverberate in debates about the possibilities of post- or transhuman futures. At the same time, demands for the application of science and technological innovation in human affairs have only increased in the fields of medicine, agriculture, communications media, transport, and weapons development. The socio-cultural momentum of science and innovation is a global phenomenon.

The outcome of this hundred-year history of science-society interactions is that in the first decade of the 21st century scientific knowledge is increasingly characterised by ambivalence – loved as well as feared, presenting both opportunities and uncertainties. The social contract for science is open to renegotiation. Such ambivalence can only be met with intelligent governance both to realise positive potentials and to mitigate unintended consequences. As science globalises, and global problems – climate change, economic inequalities, planet-scale insecurity – look insoluble without appropriate scientific innovation and transnational cooperation, debates about the governance of science necessarily take on their own global character.

Governing innovation and its discontents

Any approach to governing science must seek a balance between the bottom-up, emergent, unpredictable nature of science and top-down needs for social management. In the past, the serendipity of science has been used as an argument for governance of the products but not the processes of science. Following a linear model, from science, through technological development to social benefit, the assumption that science is autonomous and self-governing has been understood to mean that the only point of governance for innovation more broadly is the marketplace or end-of-pipe regulation.

Yet 'innovation policy' – the shaping of science and innovation – does not need to be an oxymoron. As one policy critic has argued with regard to nanotechnology, funders and regulators are starting to realise that "we vastly underestimate our ability to productively shape the scientific enterprise ([20])." Recent activities in the United States and Europe centred on nanotechnology have increasingly considered the whys and how's of shaping innovation for greater public good. The reality is that innovation is far from linear. Basic research is now driven as much by imagined technological applications as by scientific curiosity and innovation typically takes place in a web of interactions among scientists, engineers, governments, private corporations, financial investors, users, and others. To complement downstream regulation, proposals have been developed for various forms of upstream engagement

17 Edward O. Wilson, *Consilience: The Unity of Knowledge* (New York: Random House, 1998), p. 303.

18 Leon Kass, 'The Wisdom of Repugnance: Why We Should Ban the Cloning of Humans,' *New Republic*, vol 216, no. 22 (2 June 1997), pp. 17-26.

19 President's Council on Bioethics, *Beyond Therapy: Biotechnology and the Pursuit of Happiness* (New York: HarperCollins, 2003).

20 David H. Guston, 'Innovation Policy – Not Just a Jumbo Shrimp,' *Nature*, vol. 454 (21 August 2008), pp. 940-941.

that would expose assumptions hidden in practices and identify where innovation might be amenable to governance. These include constructive technology assessment (CTA), citizen consensus conferences, real-time technology assessment (RTTA) and various other methods ([21]). Another proposal has focused on 'midstream modulation' that could take place in research and development laboratories to help sensitize knowledge and innovation workers about the multiple implications of their work ([22]). Such approaches have met with modest acceptance in the public sector. But the challenges of setting goals for and managing scientific research and technological innovation are exacerbated in corporate and military contexts, where competitive pressures tend to reduce opportunities for measured reflection and public discussion ([23]).

In 2007 a previous expert group on science and governance resented to the European Commission a report, Taking European Knowledge Society Seriously, arguing a need to identify new approaches to the democratic governance of innovation. Public debates are appropriate not just with regard to the impacts of applied science and technology, but also about scientific processes and the trajectories of innovation ([24]). According to this previous analysis, there is need for an expansion from risk governance to innovation governance ([25]). Our analysis points towards the complementary extension of such governance to global levels. Indeed, as governments in many countries progressively promote the economic and societal benefits of science, its social context has become increasingly important and arguments against multi-level global governance less defensible.

As more and more societies move towards greater dependence on science and therefore devote increased public and private funds to its support, science in its own many aspects and internationally has naturally become subject to increased public scrutiny. One form of such scrutiny has been efforts to adapt New Public Management (NPM) processes that promote governance in terms of well-defined results, transparency, 'value for money' and a growing role for competition in funding. NPM approaches call for more use of internal and external evaluations and impact assessments as well as the establishment of monitoring systems in science focused on efficient use of resources, deliverable outcomes, and achieved social and economic benefits.

As economics, politics, and science become more intertwined, competitions for science funding and public interest take on a language of expectations ([26]). Corporations, governments, and scientists themselves combine to raise expectations about particular areas of science, as has been illustrated in the cases of genetically modified (GM) organisms and nanotechnology. In both cases, grand claims for environmental or poverty-alleviating benefits were initially overstated. Deploying the weight of authority, scientists simply called on the state to

21 Ari Rip, Thomas Misa and Johann Schot, eds., *Managing Technology in Society: The Approach of Constructive Technology Assessment* (London: Thomson, 1995); David H. Guston and Daniel Sarewitz, 'Real-Time Technology Assessment,' *Technology in Society*, vol. 24 no 1 (2002), pp. 93-109; James Wilsdon, Brian Wynne and Jack Stilgoe, *The Public Value of Science* (London: Demos, 2005).

22 Erik Fisher, Roop L. Mahajan, and Carl Mitcham, 'Midstream Modulation of Technology: Governance from Within,' *Bulletin of Science, Technology, and Society*, vol. 26, no. 6 (2006), pp. 485-496.

23 For a contrasting assessment, see Steven Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation* (Chicago: University of Chicago Press, 2008).

24 Ulrike Felt, Brian Wynne, et al, *Taking European Knowledge Society Seriously*, Report of the Expert Group on Science and Governance, to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission, 2007.

25 See also Brian Wynne, 'Public Participation in Science and Technology: Performing and Obscuring a Political-Conceptual Category Mistake,' *East Asian Science, Technology and Society: An International Journal*, vol. 1 (2007), pp. 99-110.

26 Nike Brown and Michael Michael, 'A Sociology of Expectations: Retrospecting Prospects and Prospecting Retrospects,' *Technology Analysis and Strategic Management*, vol.15, no 1 (2003), pp. 3-18.

serve a supporting role. As one study of the European biotechnology controversy in the 1990s argued, "the state's role was perceived to be restricted to providing a congenial environment for industrial performance, and it was no longer considered appropriate for the state to promote other social goals when regulating biotechnology (27)."

At the global level, hype surrounding emerging technologies in rich countries tends to narrow options in the developing world, where countries find themselves having to import both technological promises and governance frameworks. South Africa and Kenya hastily joined the group of countries supporting GM crops before considering appropriate legal and policy frameworks, investing in GM infrastructure before policy and legal regimes could be erected to deal with the implications of the technology (28).

The issue of how science is used to inform, support, justify or challenge political decision making has thus become problematic. One scholar introduced the term 'mandated science' (29) to describe 'the body of science or technology – includingbasic science and applied research – drawn on expressly for the purpose of public policy and regulation' (30). Others have talked about 'policy-relevant science' or 'trans-science (31)'. Science, especially in areas of strategic importance such as energy and security, is often at the heart of political debates. Members of the scientific community justifiably worry that the growth of mandated science unduly politicises their own activities and limits autonomy. Mandated science is not in itself a problem, but reveals to members of the scientific community the political contexts of their work, which can be daunting. Scientists do not have to be passive players in mandated science (32). The challenge across all levels of governance is to establish new forms of dialogue that open up the science-policy relationship (33).

The call for greater accountability and openness is challenging for many scientific systems. Peer review, for instance, is a keystone of scientific quality assurance, but sometimes functions as well as an 'old boy' or 'in-group' network that can discriminate against younger researchers, women and minorities. Additionally, investments in science compete with other public goods, especially since it is not always clear how arguments by scientists for greater public funding should be evaluated in relation to other special interest groups. As one leading critic has pointed out, "where there is power there will be abuse of it; where there are rewards there will be corruption" – something just as true in science as anywhere else (34). Autonomy and self-governance can lead to the promotion of narrow self-interests beneath grand promises, favouring inertia and established orthodoxies over the development of new disciplines and groups in pursuit of uncertain but promising research.

27 Elisabeth Bongert, 'Towards a 'European Bio-Society? Zur Europäisierung der neuen Biotechnologie,' in Renate Martinsen, ed., *Politik und Biotechnologie. Die Zumutung der Zukunft* (Baden-Baden: Nomos, 1997), pp.117-134.

28 Pamela Andanda, 'Developing Legal Regulatory Frameworks for Modern Biotechnology: The Possibilities and Limits in the Case of GMOs', *African Journal of Biotechnology*, vol. 5, no. 15 (2006), pp. 1360-1369.

29 Liora Salter with Edwin Levy and William Leiss, *Mandated Science: Science and Scientists in the Making of Standards* (Dordrecht: Kluwer, 1988).

30 Liora Salter, 'Mechanisms and Practices for the Assessments of the Social and Cultural Implications of Science and Technology,' *Occasional Papers*, no. 8 (July 1995). See http://www.ic.gc.ca/epic/sites/eas-aes.nsf/print-en/ra00006e.html. (Accessed 25 July 2008).

31 Sheila Jasanoff, *The Fifth Branch:Science Advisers as Policymakers* (Cambridge, MA: Harvard University Press, 1990); and Alvin Weinberg, N*uclear Reactions: Science and Trans-Science* (New York: American Institute of Physics, 1992).

32 John B. Robinson, 'Risks, Predictions and Other Optical Illusions: Rethinking the Use of Science in Social Decision-Making,' *Policy Sciences*, vol. 25, no. 3 (1993), pp. 237-254.

33 Robert Frodeman and Carl Mitcham, eds., 'Toward a Philosophy of Science Policy,' *Philosophy Today*, vol. 48, no. 5 (supplement, 2004); Alan Irwin, Kevin Jones, and Jack Stilgoe, *The Received Wisdom: Opening Up Expert Advice* (London: Demos, 2006); and Roger Pielke, Jr., *The Honest Broker: Making Sense of Science in Policy and Politics* (Cambridge: Cambridge University Press, 2007).

34 Ian C. Jarvie, 'Science in a Democratic Republic,' *Philosophy of Science*, vol.68 (2001), pp.545-564.

Conclusion: Towards constructive governance

All of this signals the end of an age in which science and technology served as uncontested symbols of secular progress and enjoyed enormous freedom and autonomy. Science itself, like other social institutions, has its own politics. Social relations between scientific communities, scientists as experts, society and the public have changed. The appearance of politics in science may be read as further exemplifying Adolph Lowe's astute insight that social experience has fundamentally changed from a state in which things simply 'happened' to a world in which more and more they are 'made' to happen ([35]). Paradoxically, this transformation owes its origins as well to the increased presence of scientific knowledge in both the private and public realms. Science is what enables people to make things happen. It is a capacity to act that pushes back the boundaries of what once appeared to be beyond human ability to change, alter, or manage. The result is that new knowledge and new technical abilities come to be experienced not just as benefits but also as risks to health and for some even as threats to the human condition itself ([36]). In such circumstances, science as the capacity to act must be directed towards science itself in the effort to generate a science of science and innovation polities in order to produce new mechanisms of social management and control.

To make the same point in different words: As science becomes more ubiquitous, it becomes a victim of its own success, placed under greater external pressure to reflect consciously on its political, economic, and cultural contexts. As countries and regions set their sights on becoming 'knowledge economies' and mandated science is targeted at particular objectives, there emerge new forms of 'techno-nationalism.' By contrast, scientists tend to look across national borders, creating a tension between science and national political economies. Yet links between scientists and mechanisms of global governance are typically much weaker than those with national governments. Where international organisations have the potential to govern globally, they do not have the weight, in terms of funding, steering and the use of science to complement their policies. The global governance of science thus calls for new global relations between what might be called the society of science and the larger society in which science exists, treating each as active participants in new relationships.

35 Adolph Lowe, 'Is Present-day Higher Learning 'Relevant'?,' *Social Research*, vol. 38 (1971), pp.563-580.

36 See, e.g., the argument of Juergen Habermas in *Die Zukunft der menschlichen Natur: Auf dem Weg zu einer liberalen Eugenik?* (Frankfurt am Main: Suhrkamp, 2001).

Chapter 2. **The Society of Science**

The governance of science takes place on multiple levels. Science is an expert activity dependent on interactions among specialists. Self-governance within such a social institution is not always based on a full appreciation of its broader contexts and implications. Nevertheless, any effort directed towards a global governance of science in all its contemporary complexity requires making a serious attempt to understand, engage with, and encourage governance systems within science. Formally and informally, science has its own practices, procedures and cultures that aim to ensure quality and progress. They also provide a governance framework that has to some degree adapted to the wider contexts in which science is now situated.

This chapter thus begins by considering some of the ways the society of science governs itself along with possible weaknesses of such practices. Included are discussion of scientific integrity and research ethics, paying special attention to how scientists deal with 'bad science' and misconduct – often defined as fabrication, falsification and plagiarism (FFP). It then describes how the concept of bad science has shifted in recent years to encompass what have been called 'questionable research practices.' Finally, it looks at how fostering and affirming 'good science' can involve more than simply guarding against bad science. Aspects of critical science and a trend towards interdisciplinarity open up the space for vital debates about what counts as good science in a broad social context. In significant ways, the scientific community can benefit from enlarging its own understandings of what counts as good science.

Governing serendipity

Autonomy has traditionally been seen as a major characteristic and crucial precondition for scientific progress. Although sociologists were among the first to analyze this aspect of science, perhaps the strongest defence is that articulated by physical chemist Michael Polanyi in a reflection on what he called 'The Republic of Science' ([37]). According to Polanyi, "The Republic of Science is a Society of Explorers" in which scientists, "freely making their own choice of problems and pursuing them in the light of their own personal judgement," are working under self-co-ordination of independent initiatives "guided as by 'an invisible hand' towards the joint discovery of a hidden system of things." Polanyi claimed that any attempts by external authorities to interfere in the co-ordination of science posed a threat to scientific progress. For him, "the aspiration of guiding progress of science into socially beneficent channels" was an impossible and nonsensical aim. Polanyi concluded that, when it comes to governance, "You can kill or mutilate the advance of science, you cannot shape it."

By contrast, the crystallographer J.D. Bernal, in an analysis of the 'Social Function of Science' ([38]), argued that preference should be given to the applied sciences over basic, curiosity-driven research – and that there is no moral boundary between the production of knowledge and its application. For Bernal, science is an instrument for

37 Michael Polanyi, '*The Republic of Science: Its Political and Economic Theory,*' *Minerva*, vol.1 (1962), pp.54-74.

38 J.D. Bernal, *The Social Function of Science* (New York: Macmillan, 1939).

social transformation and emancipation, and should be rooted in practical life. From this perspective, which is also that of the pragmatist John Dewey, ([39]) science should be judged by its utility broadly construed, scientific freedom is legitimately limited by governmental research policy and disinterestedness should be replaced by a comprehensive ethical obligation towards the production and application of knowledge beneficial to society. Although Bernal's position is implicit in much contemporary science policy criticism, the understanding of social benefit has too often been narrowed to economic benefit.

While it remains questionable whether 'The Republic of Science' has ever been as autonomous or self-governing as claimed by Polanyi, there is now widespread recognition of need to control, to steer and to govern the development of science. There are also questions about the limits and potential abuses of the self-governance of science. The individual actions of autonomous individuals may not scale up to the collective good. Polanyi's 'invisible hand' may be invisible simply because it does not exist. Calls for the social control and steering of science have further intensified due to the risks associated with new advances, as in controversies surrounding environmental pollution, computer and information privacy, GM foods, cloning, and stem cells research. Such controversies have led to qualifications of scientific authority and increased demands for public participation in the governance of science.

That said, top-down social control and steering of science remains problematic. Just as the self-governance of science can be abused by narrow self-interests of some scientists, political and social control can be abused by specific political or societal interests. Historical instances of such abuse range from religious opposition to new scientific discoveries centuries ago to Nazi and Communist ideologically driven distortions of research programmes. Some politically-driven research programmes such as the Manhattan project or the Apollo programme may have been technically successful even while producing results that could be contested as social goods. Approaches to global governance, therefore, need to ask not only how science does, can and should govern itself but the limits of such self governance.

A spectrum of misconduct

Scientific misconduct has been a repeated concern in the society of science. In 1830, the English mathematician Charles Babbage identified three malpractices in science: 'cooking', 'forging' and 'trimming' of data. Some science journalists have argued that the history of science is littered with multiple types of misconduct and that these remain common in current practice ([40]). Partly in response to such charges, after considerable debate, the U.S. Office of Science and Technology Policy proposed to limit scientific misconduct to "fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results ([41])." Federal funding agencies in the U.S. now require recipient institutions to establish clear policies for dealing with FFP allegations. In Europe, which does not yet have as widely instituted a definition or established policies, discussion has sometimes focused on the more general 'questionable research practices' (QRP), which covers such issues as misuse of statistics and duplicate

39 See, e.g., John Dewey, 'The Supreme Intellectual Obligation', *Science*, vol. 79 (16 March 1934), pp. 240-243.

40 William Broad and Nicholas Wade, *Betrayers of the Truth: Fraud and Deceit in the Halls of Science* (New York: Simon and. Schuster, 1982).

41 *U.S. Federal Register*, vol. 65, no. 235: pp. 76260-76264 (December 2000).

publication. The ideal is generally called 'responsible conduct of research' (RCR). The result is a spectrum which, according to one analysis, looks something like this ([42]).

RCR	**➔ QRP ➔**	**FFP**
Ideal behaviour	**➔**	**Worst behaviour**

The prevailing view within the society of science is that that FFP and QRP are limited to a minority of scientists and that the self-correcting nature of science acts to expose, punish and make both relatively inconsequential. The prevalence of FFP has been estimated at 1-2 % among active scientists, with preliminary empirical data setting QRP at 5 % or above, often exceeding 10 % ([43]). Such statistics suggest that, especially in the case of QRP, occurrence may be more consequential than commonly admitted.

In the 2000s, the issue of serious misconduct again became an issue of scientific and public discussion because of a number of new high-profile cases. In early 2002 doubt was raised, later substantiated, about Lawrence Berkeley Laboratory physicist Victor Ninov's reported synthesis of element 118. Later that year nanotechnology research by Bell Labs physicist Jan Hendrik Schön was revealed to be riddled with false claims. Both cases led to career ending sanctions, and to questions as well regarding the integrity of some collaborators and co-authors. Then even more dramatically, in 2006 South Korean biomedical scientist Hwang Woo-Suk was indicted on charges of embezzlement and the violation of bioethics laws involving human embryonic stem cell research. Late the previous year the New York Times had already concluded that "as research around the globe has increased, most without the benefit of [peer review] safeguards, so have the cases of scientific misconduct ([44])." Not even peer review journal editors seemed able to exercise effective quality control ([45]).

The soul-searching that accompanies cases of fraud and misconduct tends to produce a variety of apologies. Fraudulent scientists have been portrayed as 'bad apples' who lack the shared morals of the rest of the scientific community or are simply unaware of the rules. Alternatively, it has been argued that the problem is increased pressures on individual scientists to accelerate research and reputation, to 'publish or perish' and secure scarce funds. Yet Hwang was no outlier scientist; he was one of Korea's – and the worlds – top stem cell researchers. He must have understood the rules concerning FFP, even as he sought to serve as a model for emerging Korean bioscience. Whatever the explanation, fraud and misconduct present serious challenges to science, since their existence suggests at least some inadequacies in the way scientific practice is itself organised.

Discussions of scientific fraud and misconduct tend to present science as black and white. Closer inspection reveals that scientific quality and integrity exists in various shades of grey. As a result, the society of science has witnessed increasing attention not just to FFP but also to QRP. Scientific researchers can engage in practices that raise ethical concerns without counting as FFP. Failures by co-authors, peer reviewers, and scientific editors to detect FFP and the resistance of scientific journals to publicizing fully their mistakes are cases in point. Indeed,

42 Nicholas H. Steneck. 'Fostering Integrity in Research: Definitions, Current Knowledge, and Future Directions,' *Science and Engineering Ethics*, vol. 12, no. 1 (2006), pp. 53-74.

43 Brian C. Martinso, Melissa S. Anderson, and Raymond de Vries, 'Scientists Behaving Badly,' *Nature*, vol. 435 (9 June 2005), pp. 737-738.

44 Lawrence K. Altman and William J. Broad, 'Global Trend: More Science, More Fraud,' *New York Times*, Tuesday, December 20, 2005, p. D1.

45 For more detail, see Lawrence K. Altman, 'For Science's Gatekeepers, a Credibility Gap,' *New York Times*, Tuesday, May 2, 2006, D1.

the same study from which prevailing percentage estimates are derived revealed that many scientists report having engaged in questionable practices themselves. Other QRPs include the biased presentation of data, using unauthorised data and, pertinently for issues of global governance, conducting research in countries or regions with lower ethical or regulatory standards for the sake of convenience.

Under the QRP umbrella debates have revealed a lack of clarity about norms and rules of authorship of scientific papers. Authorship is a vital part of scientific systems of reward and recognition. Yet there are no firmly agreed upon global standards for authorship. Journal editors in the biomedical research are were the first to recognize the need for such standards. Thus evolved what now is known as the Vancouver Guidelines of authorship. A small group of journal editors published such a standard for the first time in 1979, and these have been revised several times by an enlarged group ([46]). But questions remain: Who should count as a proper author of a scientific publication? What is the difference between first, last, and other authors? What responsibility should co-authors have for the content of a publication?

As part of the growing concern for quality, definitions of what counts as bad science have evolved, although again there no strong global consensus within the society of science about the precise character of good science. Indeed, there seems only limited capacity for discussing the issue. Questions of scientific integrity, when explicitly considered, tend to be taken on by scientific funding bodies in order to ensure their money is used appropriately. Yet here too there are large discrepancies between countries and few mechanisms for seeking international engagement. Too often in the past, institutions have seen scientific integrity as a matter of ensuring compliance – eradicating the bad rather than positively fostering good practices. We are now starting to see, at an overarching level, a rekindling of interest in normative aspects of doing science.

One professional scientific effort to consider in modest depth the RCR ideal was a collaborative project of the U.S. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine along with the American Association for the Advancement of Science. These intermediate associations in the society of science have worked to explore 'responsible science' and developed guidelines for appropriate education in the responsible conduct of research. Their report is a widely-used pamphlet that has been translated and published in a number of languages, including Chinese and Spanish ([47]).

In the United Kingdom, a former chief scientific adviser to the government, recently published a 'universal ethical code for scientists.' Talking about the need for 'Rigour, Respect and Responsibility,' it was argued that the code would "demonstrate to the public that scientists take ethical issues seriously ([48])." One critical assessment, however, sees the code as based on an assumption that public distrust is caused by scientific malpractice rather

46 See '*Uniform Requirements for Manuscripts Submitted to Medical Journals: Writing and Editing for Biomedical Publication*,' updated October 2008, and available at http://www.icmje.org/

47 Committee on Science, Engineering, and Public Policy, *On Being a Scientist: Responsible Conduct in Research*, second edition (Washington, DC: National Academy Press, 1995). A third edition is in preparation.

48 Department for Innovation, Universities and Skills, Government Office for Science, '*Rigour, Respect and Responsibility: A Universal Ethical Code for Scientists*' (2007). (The author was Sir David King.)

than something more fundamental ([49]). Public unease about science is not concerned only with the issue of 'means'; it is also related to the perceived 'ends' of science, technology and innovation. Bottom-up efforts to rethink questions of scientific integrity therefore need to address the question of 'What is science for?' as part of the question 'What counts as good science?' Over the last few decades, much of this more proactive discussion has taken place in regard to the issue of 'critical science'.

Relevant science, critical science and interdisciplinarity

Even within the society of science it is increasingly recognized that science is tied to its uses and contexts ([50]). Large parts of science are now instrumentalised, either as tools for policymaking, or as fuels for technological change and economic growth ([51]). This asks scientists to engage with the context of their work, rather than assuming that it takes place in a social and -political void. The approach has led some scientists to ask significant questions about the uses to which their work is placed.

Questions have arisen about whether existing science practices and policies, especially what has been termed the commodification of scientific knowledge, may bias knowledge production. As science finds itself under increasing pressure to deliver economic growth, the desires of the market can be emphasised over the long-term common good, especially regarding global challenges such as poverty and equity, environmental sustainability and climate change. Pressures to contribute to innovation and the global competitiveness of nations may easily result in knowledge that emphasises potential benefits to certain groups and overlooks unintended risks. In most areas of research there is a striking discrepancy between the amount of research devoted to new and innovative technologies compared to that directed towards addressing potential threats to health, environment, or social welfare. This is not necessarily all wrong, since the latter type of research in many instances depends on the former. But it is still reasonable to fear that incentives for research directed towards economic innovation could become so dominating as to crowd out other concerns.

The sciences that produce technological innovation are in general ill equipped to consider complex risks, which demand inter-disciplinary attention. No single discipline can effectively screen complex risks on a pro-active basis. Yet our current system of knowledge production may have contributed to streamlining scientific disagreements to issues of mere technicalities. Within systems of scientific governance, the tendency is towards a concentration of scientific activity in areas that seem to be productive in an only limited sense of the term. Even interdisciplinarity is sometimes judged solely on its ability to advance a particular technical project. But there is need to encourage diversity of activity, which means reasserting the value of different strands of science and open debate about the value of these various strands. In the words of one sociologist of science, "debates within science

49 Robert Doubleday, 'Ethical Codes and Scientific Norms: The Role of Communicating in Maintaining the Social Contract for Science,' in Richard Holliman, Jeff Thomas, Sam Smidt, Eileen Scanlon and Elizabeth Whitelegg, eds., *Practicing Science Communication in the Information Age: Theorizing Professional Practices* (New York: Oxford University Press, forthcoming).

50 This move is sometimes characterized as a shift from Mode 1 to Mode 2 knowledge production. See Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott, and Martin Trow, *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies* (London: Sage, 1994).

51 James Wilsdon, Brian Wynne and Jack Stilgoe, *The Public Value of Science* (London: Demos, 2005).

are simultaneously debates about science and how it should be done – or who should be doing it ([52])". It is the job of critical science to air these debates, encourage them and encourage diverse science.

As a key part of civil society itself, the society of science has often served a vital critical function, contributing to the questioning of orthodoxy, particularly in the environmental sphere. This function deserves to be maintained and fostered, especially within the society of science for the good of society at large. Scientists are by and large willing to engage in such debates, but are often constrained by science policies that act to narrow their perspectives ([53]). The globalisation of science suggests the need for more global criticism, in order to avoid a merely technical or specialized globalisation.

The idea of interdisciplinarity has the capacity to open space for the re-imagination of the ends as well as the means of science. The European Union Research Advisory Board has recommended support for increased interdisciplinarity in research and education. In the United States as well the National Academy of Sciences issued a report on 'Facilitating Interdisciplinary Research.' Interdisciplinarity is an attractive policy idea, because it promises a new source of innovation. But the value of interdisciplinarity is broader than this ([54]).

The global governance of science involves crossing boundaries – between countries and between disciplines. A number of the global challenges faced today – energy, environment, welfare, social justice, public health, security and more – suggest an obvious need for inter- and multi-disciplinary collaboration. Solutions to these challenges will likely come from combinations of sciences, engineering, social sciences, the humanities, the arts, politics and economics. For present purposes, another significant feature of interdisciplinarity is that it encourages researchers to rethink the assumptions of their own disciplines as part of an engagement with others. Open-minded cooperation between the physical and biological sciences, the social sciences and the humanities has the potential to deepen the quality and relevance of research. Experiences from ethics councils and other forms of dialogue around science are that collaboration between disciplines fosters important broader understandings, which are of benefit to both scientists and the general public. Interdisciplinarity will continue to be experimental, but this should be seen as an opportunity rather than a threat. Cooperation provides opportunities for the creation of new models of research and governance from the bottom up.

Worthy of special attention in this regard are dedicated efforts to involve scholars from the social sciences and the humanities, especially philosophy and ethics, in research projects. In the United States, for instance, the Ethical, Legal, and Social Implications (ELSI) program associated most notably with the human genome project, has made a serious effort to stimulate critical interdisciplinary reflection especially regarding the good of science. Although not always as successful as some might have wanted, the ELSI approach is nevertheless and important effort ([55]).

52 Seven Epstein, *Impure Science: AIDS, Activism, and the Politics of Knowledge* (Berkeley: University of California Press, 1996).

53 Dan Agin, *Junk Science: How Politicians, Corporations, and Other Hucksters Betray Us* (New York: St. Martin's Press, 2006).

54 Studies of interdisciplinarity can be found in , for example, Julie Thompson Klein, *Interidsicplinarity: History, Theory, and Practice* (Detroit: Wayne State University Press, 1990); Peter Weingart and Nico Stehr, eds., *Practicing Interdisciplinarity* (Toronto: University of Toronto Press, 2000); Gertrude Hirsch Hadorn et al., eds., *Handbook of Transdisciplinary Research* (Springer, 2008); Thinking Across Disciplines: *Interdisciplinarity in Research and Education* (Forum for Business Education and Danish Business Research Academy, 2008); and Robert Frodeman et al., eds, *Oxford Handbook of Interdisciplinarity* (Oxford: Oxford University Press, forthcoming).

55 Erik Fisher, 'Lessons Learned from the Ethical, Legal, and Social Implications (ELSI) Program: Planning Societal Implications Research for the National Nanotechnology Program,' *Technology in Society*, vol. 27 (2005), pp. 321-328.

Open science and open access

From its eighteenth century origins, the society of science has made claims to openness. Science, unlike politics or religion, claims to engage with the physical world, to discover the way it really is. It also aspires to be open to membership without class, national, religious, ethnic, or sexual prejudice to anyone able to undergo the appropriate initiating apprenticeship. Science has, of course, often failed to live up to its ideals. It can dogmatically function as an ideology that excludes some forms of knowledge. And economic networks and cultural prejudices have limited participation in science among underprivileged groups. Yet the ideal of openness remains a dynamic force that has influenced the historical development of the society of science and continues to be manifest in such diverse forms as the 'open society' of Karl Popper and the open software of computer scientists. The concept of open access to scientific knowledge is but another peculiarly salient manifestation of a perennial scientific ideal within the scientific community.

The concept of open access focuses reflection on the issue of who controls access to scientific knowledge and by what means. Much of the debate takes place around the question of online access to scientific publication in an era of ubiquitous information. But of special concern is control of this access by legal means that assert some kind of property rights over scientific information, normally referred to as intellectual property rights (IPRs).

Patent law aims to promote innovation and the rapid dissemination of its associated knowledge. The inventor gets exclusive rights to control commercial exploitation of inventions for some years and in return discloses detailed description of the invention, opening up the new knowledge to all. The disclosure enables others to build on the achieved knowledge. In Europe there is a traditional academic exemption, mentioned in most national laws, which allows further research without payment to the inventor, if the research is not commercial. In the United Sates, legislation does not provide such an academic exemption, but in practise there are often agreements between patent owners and research laboratories, although it is not a right. A number of international instruments exist, such as the Trade Related Aspects of Intellectual Property Rights Agreement (TRIPS) and World Intellectual Property Organisation (WIPO) that bear on such issues.

The tendency for researchers to be more aware of and more obliged to look for patenting possibilities may infringe the tradition of knowledge sharing. This may present obstacles to further research and global collaboration on research projects. As revealed by discussions concerning the patenting genetic research findings, there is currently insufficient exchange between science and the law. Where discussion does take place, it tends to be procedural, paying little attention to ethical issues related to the public good.

The patent system may also be problematic for developing countries, science exclusive rights may hinder fair exploitation and use in a number of ways. In some cases IPR regimes contribute to widening divides in knowledge and research between developed and developing countries. UNESCO has taken up the topic of IPR in a global context, but there is lack of information regarding the consequences of IPR – especially the extent to which it enables or disables further research and innovation. Such divides may be exacerbated by a lack of access to published scientific research, suggesting another rationale for open access to publications [56].

56 *Open Access, Opportunities and Challenges, European Commission, 2008*, http://ec.europa.eu/research/science-society/document_library/pdf_06/open-access-handbook_en.pdf

The call for open access and for greater openness in research has been led by scientists and scientific organisations, but has also met with institutions and systems of science that act to resist change. Debates about openness in scientific research and science communication illuminate broader concerns about science's place in society and its own responsibilities in rethinking its practice and culture.

Conclusion: Rethinking good science

Given the unpredictable dimension of scientific discovery, efforts to closely control scientific progress will no doubt fail. This is the basic insight that animates the society of science and its defence of self-governance. But given the power of the society of science to influence human affairs in general, the broader society has a vested interest in insuring sound governance within science and appropriate articulation of governance of the relationships between science and society. The search for appropriate global governance of science must nevertheless begin with appreciation of some of the features of governance internal to science, which has been the theme of this chapter. Indeed, the scientific community's attempt to regulate itself through the eradication of fabrication, falsification, and plagiarism, to examine questionable research practices such as data manipulation and multiple publication, and to pursue the responsible conduct of research are to be commended and deserve support from the larger society. But the discussions of FFP, QRP, and RCR also opens up a space for a broader and more substantive consideration of what counts as good or valuable science. Under pressure from national governments and private corporations to deliver economic growth, science has been asked to redefine its own sense of integrity and to become self-critical of its social contexts. This is a valuable exercise, nevertheless limited by national borders and a tendency to remain within narrow bounds.

Attempts to launch debates over further directions of research and its socio-economic implications at global level thus remain fragmented. Some efforts have been made by international organisations (such as the Organization for Economic Cooperation and Development, World Bank, and United Nations) as well as international associations of scientists (such as the International Council of Scientific Unions, regional associations of national academies of sciences, and the World Academy of Young Scientists). These discussions are nevertheless largely restricted to small groups of scientists and experts. Some non-governmental activist organizations (such as Greenpeace) and movements (such as those in favour or nuclear disarmament or organic farming) have also made contributions to the discussion. But a system of global governance still needs better linkage of debates taking place within science to those taking place around science, in the larger civil society and policy spheres – that is, to science in society.

Chapter 3.
Science in Society

Science will always be, to some degree, self-governing. But the society of science sits in a social context that cannot be ignored. The global governance of science therefore needs to be concerned not only with all aspects of science as a common institution but also the relationships between science and society, especially as these are transformed by a globalizing world. The rapidly-changing context of global science and the pressing need to address global issues point toward needs for new forms of dialogue, across the borders between disciplines (scientific and non-scientific) and countries (developed and developing).

Again, the challenge is to seek a balance between the often competing needs for self-governing autonomy and political or social management. This chapter begins by reviewing recent dynamics in science-society relations, before turning to some of the challenges that emerge through globalisation regarding both the means and ends of science, its practices of science and its aims. In both cases, however, there cannot help but be implicit references back to internal aspects of the society of science.

From communication to deliberation

In Europe and North America the post-Enlightenment history of cultural commitment to science held scientists as the custodians of authoritative knowledge. Scientists became a new priesthood, privileged elite to whom the public deferred and from whom the public benefited ([57]). The period after the end of the Cold War witnessed significant change in the privileged position of science and in the understanding of the place of science within society. In the 1980s, policymakers and scientific organisations diagnosed a disconnect between scientific expertise and public opinion. The public appeared to be losing trust in orthodox science and levels of scientific literacy appeared worryingly low. The suggested solution, in line with the received wisdom, was a programme of science communication, aiming to promote what was then called the 'public understanding of science ([58]).'

Within a decade, however, new research and the international experience of scientific governance began to challenge this 'deficit model' of public understanding ([59]). The public was not simply lacking a kind of knowledge that scientists should supply, nor was it appropriate to learn only from scientists. What was called local or indigenous knowledge (for example, of environmental contaminations) was revealed in some cases to be more accurate, or more relevant, than decontextualised scientific knowledge. This more nuanced understanding led to attempts to actively engage European publics in processes of science and scientific governance. Efforts were made to reconstruct parts of science and parts of society to interact in myriad ways at different levels.

Selective European governments thus attempted to develop mechanisms for greater public involvement and became leaders in efforts to open up the governance of science through public participation. Initiatives as diverse as Denmark's Consensus Conferences, the United Kingdom's Science wise pro-

57 Ralph Lapp, *The New Priesthood: The Scientific Elite and the Uses of Power* (New York: Harper and Row, 1965).

58 Royal Society, *The Public Understanding of Science* (London: 1985).

59 Alan Irwin and Brian Wynne, eds, *Misunderstanding Science? The public reconstruction of science and technology* (Cambridge: Cambridge University Press, 1996).

gramme and the EU-wide Meeting of Minds citizens' deliberation on brain science have experimented with the idea of citizen participation in science and science policy formation (60). Such activities brought together scientific experts with members of the public, other stakeholders and non-science leaders. Some of these experiments took place 'upstream,' engaging with early-stage discussions of research priorities and innovation trajectories. Others focused on opening up 'downstream' issues of science-based regulation. Yet it is fair to say that development in this area remains embryonic.

Where public dialogue has taken place, it has tended to question assumptions about aspects of issues that were previously considered scientific. Dialogue can help demonstrate that forms of external governance once considered neutral or unbiased, including regulatory systems and funding regimes, regularly involve far more than a simple use of good science for the implementation of public policy. Instead, the science used is often also a vehicle for introducing (while obscuring) normative decisions that deserve to be debated on their merits. The take-up and success of these deliberative experiments has nevertheless been patchy. One clear lesson learned from experience so far is that such initiatives need to connect better to real governance decisions.

Public dialogue and opinion polling reveal that the often-cited 'crisis' of public trust in science may be more perceived than real (61). Behind the perception sits a more important concern. According to one recent analysis, "the crisis of trust in science is, in fact, a crisis of governance, and a new approach to the governance of science is needed (62)." The loss of deference to expertise reinforces the need to construct new models of governance for a more sceptical age. Finding ways to involve the public and other stakeholders across a spectrum of activities – including the assessment and management of risks, uncertainties, ethics and the funding of research – is key to the construction of successful governance. Connections with the public should no longer be viewed as exercises in better communications from a privileged elite. Policymakers increasingly recognise that deliberation is a cornerstone of good governance. What global deliberative governance might look like nevertheless remains unclear.

One analysis of how different European countries are responding to the call for deliberative governance revealed a huge divergence in approaches (63). As most European countries have moved in the general direction of democracy, local distinctions have been accentuated. Across all countries studied – Denmark, Finland, Greece, Norway, Sweden, The Netherlands, Portugal and the United Kingdom – governance was revealed in all cases to involve multiple actors beyond science and government (local, national and transnational). But following well-publicised controversies over GM crops and bovine spongiform encephalopathy (BSE), different European countries adopted different governance strategies to manage both technologies and stakeholder concerns. Across the world, we can expect such divergences to be magnified. Countries outside Europe will have different governance approaches and science in each country or culture

60 See, e.g., Lars Klüver, 'Consensus Conferences in the Danish Board of Technology,' in Simon Joss and John Durant, eds., *Public Participation in Science: The Role of Consensus Conferences in Europe* (London: Science Museum, 1995), pp. 41-49.

61 See, for example, Sir Robert Worcester, 'Public Attitudes to Science: What Do We Know?,' in *Engaging Science: Thoughts, Deeds and Action* (London: Welcome Trust, 2006), pp. 14-19.

62 Keith G. Davies and Jonathan Wolf-Phillips, 'Scientific Citizenship and Good Governance: Implications for Biotechnology,' *Trends in Biotechnology*, vol. 24, no.2 (February 2006), pp. 57-61.

63 Rob Hagendijk and Alan Irwin, 'Public Deliberation and Governance: Engaging with Science and Technology in Contemporary Europe,' *Minerva*, vo. 44, no. 2 (June 2006), pp. 167-184.

will fit into different contexts. As science globalises, and the need for global governance looms larger, we therefore need to consider some of the myriad contexts of global science within global society.

Ethical governance

As noted in the previous chapter, the scientific community has since the 1980s addressed questions of ethical governance from the inside. At the same time, from the outside, new scientific discoveries and emerging technologies have also increased public ethical concerns. Ethics has become an issue relevant to the place of science in society in conjunction with assisted reproductive technologies, embryonic stem cell research, GM foods, advanced surveillance technologies and nanotechnology – not to mention chemical, biological and nuclear weapons of mass destruction.

The move towards participation in science recognises the limits of experts – a recognition that applies as well to alleged 'ethics experts.' In the decades since the birth of the first in vitro conceived child, many countries, especially in Europe, have established ethics councils – national bodies designed to deliberate and inform on issues raised by biomedical innovation. The United States, for instance, established a commission in 1978 to formulate a definition of death that could accommodate such life-extending technologies as heart-lung machines. In 1982 the United Kingdom established a Committee of Inquiry into Human Fertilisation and Embryology (commonly known as the Warnock Committee, after its chair, Dame Mary Warnock). In Europe, France was the first to establish a more general purpose council in 1983, followed by Denmark (1989), Germany (2001), and The Netherlands (1999). Such ethics councils have undertaken to identify moral challenges, initiate ethical reflection and advise authorities, including national parliaments and governments. They have focused primarily on medical ethics, but other kinds of dilemmas, including agriculture and animals, have also been on selected agendas. The recommendations sometimes lead to governance tools, including formal regulation on, for example, assisted reproduction, cloning, stem cell research, and privacy.

Outside Europe, in the United States and Canada national commissions have been complimented by the creation of what are called institutional review boards (IRBs) at research institutions and healthcare facilities to assess the moral acceptability of research protocols and experimental therapeutic treatments. IRBs, unlike national commissions, are required to include community or public representation. Beyond the Americas, many African countries also use ethics review committees attached to institutions as instruments for ethical governance. Plans are also underway to establish a National Health Research Ethics Council in South Africa to oversee health research. In many cases, however, countries rely on their constitutions and statutory or common law for research governance and regulatory purposes ([64]).

National ethics councils are typically independent and interdisciplinary, but their variation between countries indicates something about the uncertainties of democratic governance. Some include a wide range of stakeholders – scientists, lawyers, philosophers, psychologists, religious leaders, journalists and lay members – while others have a much narrower composition. Some include politicians and policymakers, who may otherwise be unwilling to engage in awkward or risky upstream

64 C.J. Grant, M. Lewis, and A. Strode, '*The Ethical-Legal Regulation of HIV Vaccine Research in Africa: A Study of the Regulation of Health Research in Botswana, Ethiopia, Kenya, Tanzania and Uganda to Determine Their Capacity to Protect and Promote the Rights of Persons Participating in HIV Vaccine Research*,' a technical report (Pietermaritzburg: Ethics, Law and Human Rights Working Group, African AIDS Vaccine Programme, 2005).

discussions. Ethics councils often reflect a national political context. Some aim for consensus and direct impact on decision-makers while others present a more complex picture of uncertainties and available options.

A European consensus

Efforts have been made, however, to establish a transnational European consensus to provide a foundational context for the ethical for the practice of science. Associated activities and their results are, we think, particularly relevant to possibilities for the governance of science in society in a global context.

In 1998, the European Union appointed an ethics council to advise the European Commission – the European Group on Ethics (EGE) in science and new technologies. This group is independent, pluralistic and interdisciplinary, with its 15 members appointed in a personal capacity. EGE has issued reports on a series of issues, including stem cell research, patenting of stem cells, biobanks, genetic testing, clinical research in developing countries, nanomedicine, information and computer technologies, cloned meat and agriculture. Ethical considerations are included in a number of EU directives, but there are differences in the nature of obligations. In healthcare, for example, legislation for products such as medicines and medical devices in EU markets has led to a harmonised system for member states, while legislation on 'good clinical practice' establishes only minimum provisions, to be supplemented by national rules.

As part of the process of working to harmonize ethics across member states, the European Union has brought together national ethics councils in the Forum of National Ethics Councils. In 2000, a year before the white paper on *European Governance* enunciated its five principles of good governance – openness, participation, accountability, effectiveness, and coherence – the European Parliament formally adopted the *Charter of Fundamental Rights of the European Union*. Although the authority of the Charter is moral rather than legal, it emphasizes that the Union is founded on six basic values (*):

dignity – including a right to personal autonomy and prohibitions of eugenic practices, commercialisation of human body and its parts, and human reproductive cloning;

freedoms – including freedom of the arts and the sciences;

equality – meaning especially equality before the law of all persons;

solidarity – which involves a right to health care and environmental protection;

citizens' rights – including a right to good administration; and

justice – understood especially as the rule a democratically oriented legal system.

The Charter aims to preserve these common values while respecting the diversity of the cultures and traditions of the peoples of Europe, as well as the national identities and structures of member states. In this way it formulates a consensus-based context for the governance of science in European society, but one that should be relevant to the global community as well.

* However, with the prospective implementation of the Lisbon Treaty, the charter will be part of the legal framework of the European Union.

The Council of Europe has also helped set the agenda for science and ethics across Europe. The Council of Europe Convention on Human Rights and Biomedicine adopted in 1997, and based on the Convention for the Protection of Human Rights and Fundamental Freedom from 1950, is binding only for those member states that have signed and ratified it. But all European projects funded under the Framework Programmes are obligated to comply with its principles. The aim of the convention is to protect individuals against exploitation arising out of treatment or research. The parties "shall protect the dignity and identity of all human beings and guarantee everyone, without discrimination, respect for their integrity and other rights and fundamental freedoms with regard to the application of biology and medicine."

Finally, it is important to note that the European consensus is in full harmony with a number of global statements, including the *Universal Declaration of Human Rights* adopted by the United Nations General Assembly in 1948, Article 27 of which states that "Everyone has the right freely… to share in scientific advancement and its benefits." At the global level, UNESCO has likewise established the International Bioethics Commission (IBC) and an Intergovernmental Bioethics Commission (IGBC) to bring together ethical deliberation from around the world. The UNESCO *Declaration on the Human Genome and Human Rights* was adopted by the UNESCO General Conference in 1997 and subsequently endorsed by the United Nations General Assembly in 1998. Along with other points, it states that the "human genome underlies the fundamental unity of all members of the human family as well as the recognition of their inherent dignity and diversity," Moreover, the Declaration affirms that the benefits of advances in the technologies should be made available to all and that freedom of research is 'necessary for the progress of knowledge' while reiterating the principle of free and informed consent. The UNESCO *Universal Declaration on Bioethics and Human Rights*, adopted in 2005, contains further specific provisions on ethical issues related to medicine, life sciences and associated technologies and advocates several ethical principles, including human dignity, consent, autonomy and responsibility, privacy, equity and justice, solidarity and benefit sharing – all of which echo or are echoed in various statements of the European consensus.

Ethics across borders

These emerging governance structures respond to a need for the ethical oversight of science and innovation in society. But their presence poses a challenge to governance at a global level. Although the European ethical consensus may be more or less accepted by many countries, its enactment varies widely. The UNESCO Declaration, too, allows for a variety of implementations even though the wording is universal. In practice, global declarations, attempting to harmonise ethical standards, often end up at the lowest common denominator. Even so, resulting values may be prioritized differently in different regions, cultures and traditions. There may be no such thing as a set of 'European' ethical values ([65]), but there are clearly tensions between European and some other approaches to ethics, such as those more typical of the United States. In the United States, for example, there is a tendency for *autonomy* to outweigh *dignity* in ethical decision making, whereas the opposite is the case in Europe. The challenge therefore is to encourage the harmonisation of ethical values as part of a long-term project of global reflection on ethics, while recognizing and learning from diverse ethical practices.

65 Hermerén Göran, 'European Values – and Others; Europe's Shared Values: Towards an Ever Closer Union?,' *European Review*, vol. 16, no 3 (2008), pp. 373-385.

Reflection on the global ethical governance of science cannot help but reveal further tensions between universal principles and local approaches. Especially is this likely to be the case in international research collaborations, which have increased between developed and developing countries. European and North American scientists and corporations now often see countries such as China and India as attractive for science in general and biomedical research in particular. Research there is cost-effective, with a ready supply of patients, hospitals, rich genetic resources and untapped markets. Yet even though leading scientists in many developing countries have been educated abroad, local Asian traditions, cultures and political situations may be sharply different. Differing perspectives on medicine, personhood, and ethics are potential sources of misunderstandings that can affect both formal governance frameworks and informal scientific practises.

Consider an example from China. Traditional Chinese cosmology sees the world as composed of *qi, yin, yang*, and *wuxing* (five elements, such as *metal, wood, water, fire* and *earth*), not of molecules, atoms and genes. The Chinese concept of personhood is not as substantial as in Europe but relational. The Chinese person is always interconnected with others, with parents at birth, then with brothers and sisters, later with other relatives, friends, neighbours, co-workers and community members. In Confucianism, which continues to be widely influential among the Chinese people as well as throughout other parts of Asia, the normative requirement for inter-personal relationships is *ren* – for others. It is this that defines the difference between people as moral agents and animals. In this world view traditional duty and virtue function as more important ethical concepts than utility or rational imperatives. Virtuous moral agents are those who consider their duties towards others instead of making claims on other to recognize their rights. Moral education of scientists is thus likely to be thought more important than the legal regulation of science.

Non-European cultures and informed consent

The challenge of enacting science in different societies can be illustrated in more detail by considering the practice of free and informed consent, which is fundamental to much biomedical, psychological, and social science research with human participants as practiced in Europe and North America. In such research human subjects will sometimes be exposed to risks – physical risks or risks to their privacy or values – for the benefit of society as a whole. But such exposure is only legitimated by the free and informed consent of participants in accord with a principle that has become increasingly central to bioethics ([66]). The enacting of informed consent is nevertheless complex, especially when efforts are made to transfer this principle with deep European historical and cultural roots to quite different socio-cultural contexts.

Just as Germany's experience of science under the Nazis still shapes its approach to controversial biomedical science, so in many developing countries, there is a fear of 'research' or 'experimentation' using local populations that is often rooted in painful histories of exploitation. In addition, subjects who live within a world view in which *qi, yin, yang*, and *wuxing* are more significant than molecules, bacteria, viruses and genes may find it difficult to understand information provided to them in the language of contemporary biomedical science.

66 Ruth R. Faden and Tom L. Beauchamp, *A History and Theory of Informed Consent* (New York: Oxford University Press, 1986). See also Pamela Andanda, 'Informed Consent,' *Developing World Bioethics Journal*, vol. 5, no. 1 (2005), pp. 14-29.

Such stark difference raise questions about the extent to which consent can truly *informed* in a Chinese socio-cultural context.

Cultural attitudes towards scientists and physicians can also affect the practice of *consent*. In Europe and North America some measure of patient scepticism has become customary with regard to the authority of the expert representatives of biomedicine. In other cultures where personal connections are prized and medicine is still highly paternalistic, patients are more likely to believe what they are told without question.

Finally, many developing countries have less individualistic cultures than is typical in Europe. Individuals are likely to be more deeply embedded in family and community. In the clinical context it is the family that provides patient's with care and emotional as well as financial support, which means the family is also involved in any consent-giving process. The subject of consent may be less an individual and more the head of a family, clan, village, or tribe. In such cases this issue becomes one of 'family consent' or 'community consent ([67])'. In less individualistic cultures, in which orality may predominate over literacy, a person may also resist signing a consent form because oral commitments are valued over written ones and there is a history of written documents being used to harm rather than to help.

Certainly historical research has shown that that the practice of science is often quite different from its rhetoric, and that science has in non-European societies frequently been in the service of an exploitative nationalism. Claims for the universality of science can obscure differences in local context and interpretation. Regulation, while claiming to be based on nothing more than scientific evidence, can look very different in different countries ([68]). Similarly, the process of innovation can vary enormously from social context to social context and thus to resist governance in a wide variety of ways. The challenge is to openly negotiate difference rather than retreat to assertions of universality.

The challenge of 'ethics-free zones'

A major complication for our picture of collaboration on questions of ethics and science, and a barrier to global dialogue efforts, is the existence of 'ethics free zones.' In such places ethical oversight may be severely limited or non-existent, and the ethical principles mentioned above not accepted or accepted but poorly implemented. As globalisation makes the transfer of knowledge, people and technologies easier, flattening the world of research, these ethics-free zones present an immediate challenge to global governance.

A 2004 report from the British Nuffield Council for Bioethics considered issues of collaborative research involving developing countries and identified an absence of ethical governance as a key concern ([69]). They identify an alienation from European models of ethics as contributing to a lack of capacity to build their own governance frameworks. What they call the 'bewildering multiplicity of guidelines, regulations, declarations and recommendations on the ethics of research' can clash with local

67 L. O. Gostin, 'Informed Consent, Cultural Sensitivity and Respect for Persons', *Journal of the American Medical Association*, vol. 274, no. 10 (13 Sept. 1995), pp. 844-845.

68 See, for example, Sheila Jasanoff, *Designs on Nature: Science and Democracy in Europe and the United States* (Princeton, NJ: Princeton University Press, 2005).

69 'The Ethics of Research Related to Healthcare in Developing Countries.' a follow-up Discussion Paper based on the workshop held in Cape Town, South Africa 12-14th February 2004.

beliefs and practices. A lack of ethical engagement makes these developing countries vulnerable to exploitation ([70]).

The existence of ethics-free zones creates room in the short term for the importing of unethical research. Practices that are banned elsewhere might be permitted, explicitly or implicitly, by countries eager to seize competitive advantage in certain research areas. Examples have already been documented of 'procreative tourism,' where couples travel to another country to obtain egg-donation or surrogate mothers, 'organ tourism,' where people travel to other countries to have an organ transplantation they cannot have in their own country and clinical trials taking place in developing countries without proper consent. Some have commented that the competition for patients may create the same regulatory 'race to the bottom' that has affected other global markets.

Despite efforts such as the EU Charter and the UNESCO Declaration, ethics-free-zones will continue to exist. The challenge, which can only be met globally, is to diminish their number and impact, ensuring adequate protection for individuals as part of a global approach to ethical governance. The task is twofold: first, to ensure that that international harmonisation of ethical principles takes on board local concerns while clarifying widely-accepted principles and practices; and second, to build the capacity of order developing countries in ethical governance so that they can scrutinise and review protocols.

Science divides

At the global level, the most visible challenge to governance and systems of ethics is that of global equity. Talk of 'science divides' in the context of global governance seems strange, given long held assumptions that scientific advances aim at, or have the effect of, bridging the gap between rich and poor, developed and developing worlds. In his famous lecture on science *The Two Cultures*, C.P. Snow saw the global divide between rich and poor as a challenge that the ability of science would be erased within half a century. He predicted, of global poverty, that "whatever else in the world we know survives to the year 2000, that won't ([71])."

The reality, of course, is that the gap has grown wider over the years. The divergence between developed and developing worlds has a number of causes, related to the complexity of science, innovation and their global governance. There has been plenty of analysis of what are often called 'technological divides,' looking at access to technologies, the distribution of technological benefits and risks, and the capacity to innovate. The diagnosis is pretty clear. According to one observer, one third of the world population is neither able to produced its own technological innovations nor have access to the technologies developed by others. Yet science and technology themselves provide no easy answers. Only at a global level can governance structures begin to change systems of research and innovation so that they address global goals, with one potential resting in collaborative research ([72]).

70 See, e.g., the case of AZT trials in Uganda, which took place without any discussion of post trial availability of the drug to the participants or the community, and the drugs were later determined too expensive. Ruth Macklin, 'After Helsinki: Unresolved Issues in International Research,' *Kennedy Institute of Ethics Journal*, vol. 11, no. 1 (March 2001), pp. 17-36.

71 C.P. Snow, *The Two Cultures and the Scientific Revolution* (Cambridge: Cambridge University Press, 1959).

72 Michael J. Malinowski, *Biotechnology: Law, Business, and Regulation* (Gaithersburg, MD: Aspen Publishers, 1999).

One leading thinker on issues of science and development notes, however, that while collaboration has huge potential benefits, it is often interrupted by an overemphasis on the protection of IPR (73).

Collaborative initiatives are already underway in specific areas insofar as stakeholders are able to approach the issue of technological divides pragmatically, starting with what they know, in specific fields in science. At the University of Toronto, for instance, the Canadian Programme on Genetics and Global Health has proposed the establishment of Global Genomic Initiative (GGI) to address the 'genomics divide.' One suggestion under this programme is that genomics knowledge should be considered as a global public good, similar to the status given to biodiversity or the ozone layer, in contrast to the growing privatisation of genomic knowledge taking place across the Western world (74). The proposed GGI is intended to provide a system of global governance, while boosting the biotechnology capacity of poor countries, and leading the development of ethics policies. The initiative would consist of a network of researchers, government staff, non-governmental organizations, and citizens groups.

Current initiatives notwithstanding, the recent Helsinki Process has explored the prospects of bridging global divides through inclusive governance. It has clearly shown the need to address concerns related to scientific and technological divides holistically, looking at systems of science and global cooperation (75). The Helsinki Process brought together stakeholders from the north and south aiming for a dialogue that would build capacity for developing national programmes that think globally. The process was a joint initiative of the governments of Finland and Tanzania. It was launched in 2003 as a response to the call for a forum to facilitate multi-stakeholder dialogue on the possibilities offered and challenges posed by processes of globalisation. Its remit was broad – development, peace, security, environment and human rights, but its achievements provide some insight for science and development globally. The process developed a new model for North–South multi-stakeholder cooperation in global problem solving and mobilised the necessary political will to implement the proposals. Their conclusion provides a manifesto for global governance. "multi-stakeholder cooperation is not just a methodology for action: it is the realpolitik of the globalised era to recognise that lasting solutions to a given problem can only be found when all the actors affected by a given issue and all the actors capable of impacting that issue are included in the search (76)."

The proposals on governance are worth highlighting here:

1. There is a need to bring about a paradigm shift by linking the rich and the poor, the global and the local, the grass roots and governments.

2. It is important to strengthen cooperation between different stakeholders in governing globalization. Particularly, it is important to find a common platform since it is very difficult to forge cooperation, e.g., between civil society

73 Calestous Juma, '*Intellectual Property Rights and Globalization: Implications for Developing Countries*,' Science, Technology and Innovation Program, Discussion Paper No. 4, Center for International Development (Cambridge, MA: Harvard University, 1999).

74 Tara Acharya, Abdallah S. Daar, Halla Thorsteinsdóttir, Elizabeth Dowdeswell, and Peter A. Singer, 'Strengthening the Role of Genomics in Global Health,' *PLoS Medicine*, vol. 1, no. 3 (Dec. 2004), pp. 195-197.

75 *Final report of the Helsinki process on globalization and democracy: a case for multi stakeholder cooperation* (September 2008). Available at http://www.helsinkiprocess.fi/netcomm/ImgLib/33/257/HP08_report_web.pdf

76 Helsinki process Secretariat (February 2008), '*Inclusive Governance – Bridging Global Divides*' (27th–29th November 2007, Dar es Salaam).

movements which are anti-globalization and business interest groups which are pro-globalization.

3. There is a need to multi-stakeholder cooperation in international and regional organizations.

Implementing such proposals, and building genuinely collaborative global science, clearly requires a degree of capacity building. The global governance of science needs to pay close attention to the capacity for different countries and regions to drive and control science and innovation.

Capacity building in the developing world

The divide between rich and poor countries on science is one of access, ownership and control, but it is also one of capacity – to research, innovate and educate. According to one analysis, the challenge of capacity building needs to be met with a clear approach based around: ([77])

- Investing in centres of excellence as a way of developing high-calibre national research capability;
- Supporting innovation at the village level by nurturing local cottage industries, which are as important as large industrial initiatives; and
- Building networks should to link the small enterprises at the village level. This will help towards the effort of building human resources and capital.

Rwanda provides an interesting example of a bold approach to science-led development. The Rwandese approach has been to develop a policy aimed at improving skills and knowledge among the population; maintaining the viability of and enhancing opportunities for growth in rural areas; and integrating technical education with commerce, industry, and the private sector. This policy was converted into detailed, specific programs with help from the World Bank ([78]).

The Network of African Science Academies (NASAC) propose an approach to scientific capacity building that mixes elements of health competition – such as the nurturing of world-class universities in each country – with large doses of international cooperation, among African countries and with developing and developed countries across the world ([79]).

Capacity building for science needs to also include capacity building for governance, to provide a strong foundation for collaborative research. The Pan-African Bioethics Initiative (PABIN) is one such effort to build capacity for ethical governance. Its approach to capacity building is to involve international agencies such as UNESCO to assist in matters of training and WIPO in intellectual property rights.

Conclusion: Science in the globalizing society

This chapter has described rapid changes in the way that increasingly powerful science is under-

77 Juma, C., Fang, K., Honca, D., Huete-Perez, J., Konde, V., Lee, S.H., Arenas, J., Ivinson, A.,Robinson, H. and Singh, S. (2001) 'Global governance of technology: meeting the needs of developing countries', *Int. J. Technology Management*, Vol. 22, Nos. 7/8, pp.629–655.

78 Alfred J. Watkins and Anubha Verma, eds, (2008). *Building Science, Technology and Innovation Capacity in Rwanda: Developing Practical Solutions to Practical Problems*. (Washington, DC: International Bank for Reconstruction and Development/the World Bank, 2008).

79 Joint Statement to African Science Ministers and Heads of States and Governments by the Network of African Science Academies (NASAC): 'Building Science, Technology and Innovative Capacities in Africa.'

stood and questioned by various stakeholders. Science, especially biomedicine, asks larger and larger ethical questions, testing a society's capacity to realise its benefits while minimising its risks. Europe has been at the vanguard in establishing new structures for ethical governance, all of which aim to initiate new forms of dialogue. As science globalises, ethical, deliberative governance needs to take place globally.

The European Union now needs to build on its leadership of such debates in order to learn from and extend initiatives such as the Global Ethics Forum. It needs to consider how activities that currently fall under the heading of 'science and society' can be scaled up and connected to issues of global concern. Global governance is made both more important and more complicated by science's historic inability to address divides between rich and poor countries. Only at a global level will we be able to link the various actors and stakeholders required to broaden technological access and control and innovation capacity.

As institutions involved with global governance addresses questions of science's ethical dimensions and its connections with society, they must strike a balance between paternalism and irresponsibility. Global governance needs to aim at agreeing and harmonising general ethical principles, stamping out ethics free zones that still remain. But it must also take into account local cultures, religions and traditions as a vital part of the necessary dialogue. This dialogue should take an approach of reconciliation, building capacity for the management of tensions and conflicts that are an inevitable part of collaborative global science.

Chapter 4.
Conclusions and Recommendations: Towards a Vision of Global Governance

Having reflected on issues related to the global governance of science from the perspectives of the society of science and of science in society, it is appropriate to summarize our conclusions. Following these conclusions, we venture a brief set of recommendations, moving from science to European engagement and potential contributions to global governance. Both conclusions and recommendations remain grounded in a belief which has animated this report from the beginning, that European experience is of significance to the global community, and in an emerging vision for a multi-levelled global governance of science.

Conclusions: From Europe to the world

In 2000, the European Union adopted the Lisbon strategy for growth, aiming to create 'the most competitive and dynamic knowledge-based economy in the world' by the end of the decade. A key means to this goal was establishment of the European Research Area (ERA), structured around policies that would advance science and innovation while strengthening European unity. Two years later, in Barcelona, a target was set for R&D expenditure, aiming at an EU-wide average of 3 % of GDP, from a mix of public and private funding. In 2004, however, a working group report evaluated progress towards this goal and was highly critical: "One of the most disappointing aspects of the Lisbon strategy to date is that the importance of R&D remains so little understood and that so little progress has been made (80)." A subsequent report reached a similar assessment: "Europe and its citizens should realise that their way of life is under threat but also that the path to prosperity through research and innovation is open if large scale action is taken now by their leaders before it is too late (81)."

At the same time, however, it is not clear that ERA success rests solely with the greater funding of science. Rhetorical appeals to 'innovation' and 'knowledge economies' can be misleading, emphasizing inputs to science and innovation while failing to assess outputs and context (82). Science policy appeals too often stress competition or 'keeping up' in terms of inputs rather than collaboration or pursuit of the common good, and are wary of all regulation – except that devoted to IPR. But the good knowledge society is as much about the governance of knowledge as it is about producing knowledge.

Policy discussions often worry that excessive attention to the governance of science might hold back European science and innovation while the emerging knowledge economies of China and India forge

80 *'Facing the Challenge: The Lisbon Strategy for Growth and Employment,'* Report of the High Level Group, chaired by Wim Kok (Brussels: European Commission, 2004).

81 *'Creating an Innovative Europe,'* Report of the Independent Expert Group on R&D and Innovation, chaired by Esko Aho (Brussels: European Commission, 2006).

82 See, e.g., Daniel Sarewitz, Guillermo Foladori, Noela Invernizzi, and Michele S. Garfinkel, 'Science Policy in Its Social Context,' *Philosophy Today*, vol. 48, no. 5 (Supplement 2004), pp. 67-83; and Daniel Sarewitz, 'Does Science Policy Matter?', *Issues in Science and Technology*, vol. 23, no. 4 (Summer 2007), pp.31-38.

ahead, unencumbered by such considerations. But we should resist such myths of the 'wild East' in the way we think about global science. Seeing China and India solely as fast-moving, unregulated competitors fundamentally affects how we construct governance processes. This is a counsel of fear, leading to a 'race to the bottom' for scientific, regulatory and environmental standards.

Instead of seeing Europe's progress towards a more democratic governance of science as a barrier to our success in the global knowledge economy, we should consider how it might become a different form of advantage, opening up new opportunities for innovation. Looking beyond Europe, our goal should be to explore different processes of governance, ethics and public deliberation to see what we might exchange, import or export. We need to develop networks which allow policymakers and scientists in Europe to forge common purpose and alliances on these issues with their counterparts in emerging economies.

It may well be that a European competitive advantage rests as much if not more with its institutions of social management, its principles and ideals, its creative and critical reflection on the governance of science as on the production of scientific knowledge. Indeed, the construction of systems for the global governance of science is vital if science is to realise its potential and contribute to the solution of global problems. Additionally, this governance needs to involve proactive efforts from a range of actors at multiple levels across science as a whole and through the engagement of many participants in all countries where science is to prosper – internal and external, bottom up and top down.

Our hope is that this report may be able to assist the Governance and Ethics Unit (Science, Economy and Society Directorate of DG Research, European Commission) in promoting vital discussions that will advance collaborative understandings of science and global governance. It is our belief that two sets of European values can be foundational to such discussions:

1. the principles identified by the European Union as vital for governance – proportionality and subsidiarity as extended in openness, participation, accountability, effectiveness and coherence;

2. the fundamental rights of the European Union – as summarized under the headings of dignity, freedoms, equality, solidarity, citizens rights and justice.

Both sets of values provide the basis for enhancing global governance of science within the ERA and for taking the search for global governance beyond Europe itself – for the common benefit of Europe and the globalizing world.

To this end, our report has considered the role of what we called the society of science in reimagining governance systems. The contribution of scientists themselves, as individuals and as members of institutions, is crucial. Science, as a globally networked activity, provides an unparalleled location in which to begin debates that necessarily cross disciplinary and national boundaries. Debates about science within the global scientific community open up new discussions that are closed down by narrow policies of techno-nationalism. But debates within the scientific community must also reflect the external context of science. The activities of scientists resist close management, but they are amenable to the influence of governance. Systems of ethical governance, for instance, now need to open up to operate globally and early experiments to democratise the governance of science need to connect more directly with policymaking ([83]).

Indeed, although at the present there are few if any global institutions sufficiently robust to globally govern science and innovation, among the important institutions on which one might build are international professional scientific societies (such as the International Council of Scientific Unions or ICSU and the American Association for the Advancement of Science or AAAS), United Nations agencies such as UNESCO, international codes of ethics in science and engineering, and various regimes for the protection of intellectual property. These are institutions that the ERA and European efforts are well situated to enhance, appealing precisely the values of good governance and human rights.

But global governance cannot be limited to scientists alone. Global governance also demands engagement with the larger society in which science exists, from the nation state in all its dimensions of public and private sectors to international institutions and an emerging global civil society. Links with the private sector need to broaden beyond aspects of regulation to encourage companies to contribute to the realisation of global goals through global science. In addition, science needs to become responsive to the bottom-up values of public groups and be encouraged to play its own role in an emerging international civil society. New mechanisms for multi-stakeholder corporation will not provide a miracle cure for global governance. They may even make the challenge of governance more complex. But the challenges simply cannot be successfully tackled without the involvement of all relevant stakeholders, even if this requires additional complexity.

The building of systems for global governance cannot be immediate. The process is necessarily evolutionary, involving aspects of social learning, exchange and experimentation. We cannot expect change overnight, but our hope is that this report helps to clarify the necessary direction in which global governance must travel.

Modelling a reconciliation approach

Much of our report has focussed on the need for deliberative ethical governance of science at various levels. But given divergent approaches to ethics around the world, how might global governance proceed? How can European experience best be shared with the global world? We think it is useful to compare three approaches: fundamentalist, modernist and reconciliationist. Although each is to some degree an exaggerated model, a comparison may nonetheless be helpful in pointing towards a new ideal.

First, a *fundamentalist* approach involves a total commitment to the beliefs and values of any traditional culture in which scientific research is conducted. The ideal here is that science should remain subordinate to a historical culture. But a fundamentalist attitude could easily violate international and European guidelines on research ethics and put European researchers in the position of being unable to protect the rights and welfare of human subjects. While it might allow for developing countries to build their own scientific capacities, in the long term fundamentalism is likely to mean that collaborative research becomes impossible for European scientists and institutions.

83 For further discussion of this point, see '*From Science and Society To Science In Society: Towards a Framework for "Co-Operative Research"*,' Report of a European Commission Workshop, rapporteur Andy Stirling (Brussels: European Commission, 2005).

At the other end of the spectrum, a *modernist* approach entails total commitment to European scientific cultural values, as embodied in European research ethics guidelines, completely disregarding the beliefs and values in non-European societies. The ideal here is that science as conceived and practiced in Europe should dominate all other cultures into which it might be introduced. This attitude, by ignoring any positive roles played by aspects of local culture, will exacerbate existing tensions and, again, in the long term, undermine opportunities for collaboration.

Given the unacceptability of these two extremes, an alternative might be described as *reconciliationist*. A search for reconciliation would seek to implement European scientific practices and guidelines on research ethics while respecting local values and trying to assimilate positive elements of local cultures into cooperative projects. To have science that is ethically bound both by European and non-European values, we will need, for instance, to identify the core of the principle of informed consent, as one of the major pillars of European biomedical research for the protection of human participants, and discover ways to practice it that harmonise and even enhance local cultural values.

The core of the principle of informed consent consists of, first, faithfully disclosing information adequate for patients or human research participants to make decisions without distortion, covering-up or deceit; second, actively helping them to understand the information provided; and third, upholding free consent without undue inducement and coercion insofar as people are competent to make decisions or proxy consent when they lack full competency. This core provides a starting point for taking ethics across cultures, allowing us to see, and adjust the peripheral parts of informed consent.

Peripheral aspects include the ways in which information is disclosed (using written materials or video), the ways patients or participants express consent (written form with signature or orally with a witness), and how the wordings are used in consent forms (whether using the wordings 'research' or 'experiment') or family and community involvement in the process of informed consent. These aspects should be adjustable to culture and local context.

But this example perhaps over simplifies the issue; the reconciliation approach will not be easy. The implementation of a reconciliation approach to cross-cultural research ethics will raise many difficult issues. Important distinctions will need to be clarified, such as the difference between scientific research (including clinical trials) and medical care. The involvement of family individual consent may in some cases abridge respect for privacy or other values. In addition to questions of values, global ethical governance will need to consider issues of possibility and prudence in crossing diverse social boundaries. Different countries will have different policy, regulation and enforcement systems, and governance frameworks need to consider how such can be accommodated. As one bioethics policy adviser noted in reference to his own experience in considering connections between bioethical principles and actual policymaking, it is a matter of prudence "which moral imperatives that arise out of the study and consideration of bioethical issues should be reflected in public policies that govern us ([84])." As he comments further: "No set of abstract rules can be expected to satisfy the particular contingencies represented by the cultural traditions

84 Harold T. Shapiro, 'Reflections on the Interface of Bioethics, Public Policy and Science,' *Kennedy Institute of Ethics Journal*, vol. 9, no. 3 (Sept. 1999), pp. 209-224.

and uncertainties that must be accommodated in real public policies… collective rules of conduct must be constantly reviewed and perhaps revised and updated." We should therefore recognize that the approach of reconciliation should be one of fostering global dialogue not just on principles but also on their application. It is our belief that grounds for agreement can be found despite local differences in emphasis on certain values or definitions of problems. But we should not pretend that this is easy, given that such dialogue tends to scrutinize the political control of science, inviting broad stakeholder interest. In such cases, too strong an emphasis on consensus can, as others have observed, "lead to underestimation of risks and objections, ignoring of unpopular viewpoints, or failure to consider alternatives or additional information ([85])."

Recommendations: In the name of global governance

Our analysis of the needs and opportunities for the global governance of science began by adopting a general conception of science as a social institution that produces knowledge oriented towards action and identifying two senses of global governance: comprehensive and international. In the context of international relations, 'global governance' emphasizes the influence of non-state actors and is thus peculiarly relevant to science, which is governed internally by members of the society of science and externally through interactions with the larger society that encompasses science. In both cases, science has since the end of World War II been undergoing changes that have intensified the practices of and need for global governance. As science has become progressively dependent on economic support from society, its outputs have been increasingly tied to social and economic needs. At the same time the unintended consequences innovation have presented society with new challenges and risks amplifying demands that the pursuit of science better reflects social concerns.

As a location for global governance, the society of science tends to be concerned with the means rather than the ends of science, with an emphasis on avoiding fraud and misconduct, raising awareness of other questionable research practices and education in the ideals of the responsible conduct of research. Given that we judge this, however, limited, a good thing, our first recommendation is that:

> ***RECOMMENDATION 1****: Within the society of science, practices of ethical governance should be promoted – by e.g., grant activity requirements, educational programmes, research projects and related conferences or other appropriate means.*

Internal efforts at ethical global governance – meaning, the ethical governance of science as a whole – are to be commended and supported with all appropriate measures by the larger society in which science necessarily exists.

At the same time, although the pursuit of a suitable global governance of science properly begins with appreciation of the internal governance of its means and methods, this is not enough. In a world of competing goods and limited resources – in which science is not the only good and all research programmes are not equally able to be funded – the governance of means must be complemented by a governance of ends. Thus, our second recommendation is that:

85 Ruth Ellen Bulger, Elizabeth Meyer Bobby, and Harvey V. Fineberg, eds., *Society's Choices: Social and Ethical Decision Making in Biomedicine* (Washington, DC: National Academy Press, 1995).

***RECOMMENDATION 2**: Members of the society of science should be encouraged to become self-critical – by, e.g., required collaboration with complementary disciplines and non-scientists in order to better recognize the ways they are influenced by larger social contexts.*

That is, scientists, as researchers and as citizens, should be encouraged to reflect on the ends of science as well as the means. One effective way to promote such reflection is by means of what might be called broad interdisciplinarity, interdisciplinarity not just among scientists but interdisciplinarity that involves social scientists, historians, philosophers, and other disciplines.

Additionally, as one way to dilute the impact of limited self-interests upon science, we recommend that:

***RECOMMENDATION 3**: All scientists should be required to make the results of their research as widely available as possible – by adoption of open access publication protocols.*

The results of science should be made as widely available as possible by adoption of open access protocols of publication, since open access is most likely able to enhance wide reflection both within and without science on science and the common good. Open access would further benefit the sharing of science and scientific collaborations between developed and developing countries.

Within Europe it is also important to pay particular attention to the European Research Area as a kind of laboratory for exploring opportunities to practice the global governance of science. With this in mind, we recommend that:

***RECOMMENDATION 4**: All ERA research projects, including collaborations with scientists in other countries, should seek ways to enact basic fundamental rights of dignity, freedom, equality, solidarity, citizens' rights, and justice in ways that also seek to respect and learn from the social and cultural contexts of non-Europeans – by, e.g., expert and public deliberations that develop and apply ideals of reconciliation.*

When fostering such basic fundamental rights, it is crucial not to simply apply such rights in any formulaic or non-thinking manner. There are general issues of the place of science in society that call for careful reflection. Thus, we further recommend that:

***RECOMMENDATION 5**: ERA research should be developed to promote critical reflection and discussion with regard to both the means and ends of science – by means, e.g., of selective research projects and public activities that require interdisciplinary collaboration and citizen participation, including reflection of the ways in which the principles of European governance and basic fundamental rights serve as appropriate and applicable guidelines for the practice of science.*

With regard to the place of science in society, it is clear that another evolution has taken place: from one-way communication by scientific experts to society towards two-way deliberation between scientists and members of the non-scientific public. As science, especially biomedicine, raises larger and larger ethical questions, testing the abilities of society to adjust to its implications and make measured use of its promises, risk has become a major topic of reflection. Europe has taken a leadership role in seeking to establish appropriate societal governance structures, emphasizing repeatedly the need for science-society dialogue. But as science globalises, ethical, deliberative governance needs to take place globally. To this end, we further recommend that:

> ***RECOMMENDATION 6****: The European Union should seek to extend to the global level its leadership in working to harmonise the internal and external governance of science across national boundaries – by furthering research and discussion on the global governance of science and seeking to develop appropriate protocols and their application for global collaboration.*

All six recommendations thus point towards deepening global governance within the ERA and extending global governance beyond the European context. The goal is to seek ways to share European aspirations and experience in regard to the governance of science with the global world itself – for the common good of both Europe and the world, learning from while contributing to and with those who are becoming collaborators in the globalization process.

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This report is the product of an expert group acting under a mandate from the European Commission Directorate General for Research to which legal scholars, sociologists, philosophers and political scientists from Europe, the United States of America, China and South-Africa have contributed.

This report seeks to advance a vision of global governance for the common good that invokes European principles of good governance and fundamental rights. It is our belief that the European Union as a political entity situated between the national and global levels, with its principles of good governance, its charter of fundamental rights and commitments to a European Research Area, is ideally placed to encourage critical reflection and undertake practical leadership in relation to the global governance of science and innovation. Our recommendations are addressed not only to policymakers in the European Commission and the Member States of the EU, but equally to those organisations worldwide operating within and around science.

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