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Challenging Futures of Science in Society

Emerging Trends and cutting-edge issues

the MASIS report

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EUROPEAN COMMISSION

Challenging Futures of Science in Society
- Emerging trends and cutting-edge issues -

Report of the MASIS Expert Group
setup by the European Commission

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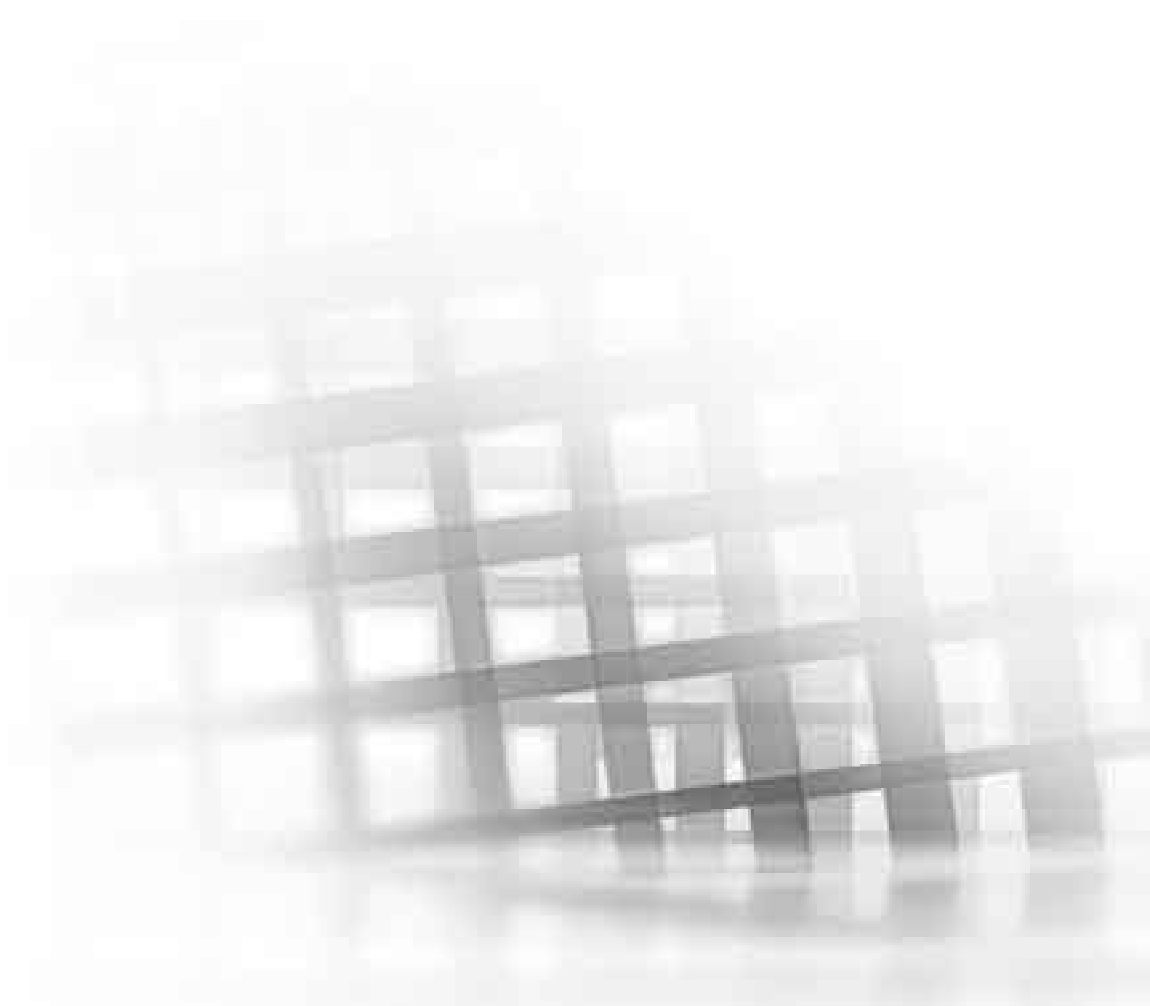
Universal Declaration of Human Rights,

Article 27:

Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits.



FOREWORD

SCIENCE IN SOCIETY:

TOWARDS REINFORCING THE SOCIETAL DIMENSION OF THE EUROPEAN RESEARCH AREA

The 2020 Vision for the European Research Area, adopted by the Council in December 2008, underlined that the ERA is firmly rooted in society and responsive to its needs and ambitions in pursuit of sustainable development. In July 2009, the Lund Declaration called for a new deal in European Research advocating that the identification of the Grand Challenges must engage the major stakeholders including the European institutions, business, public services, NGOs and the research community.

Citizens have an increasing and widely acknowledged stake in science, research and innovation. The objective of the programme 'Science in Society' in FP7 'Capacities' to reinforce the societal dimension of the European Research Area is intrinsically linked with the efforts to revitalise the economy and improve the quality of life in Europe. It supports European trans-national research and policy activities, with a focus on the dynamic governance of the research system, the ethical soundness of research and the responsible conduct of science, public engagement in science and involvement of Civil Society Organisations, the gender agenda and the promotion of scientific education, scientific culture and science communication.

This report by the MASIS expert group is the first step of an innovative initiative of the European Commission, the MASIS Project: MASIS stands for Monitoring Activities of Science in Society in Europe. It represents a collective overview on emerging trends and cross-cutting issues in Science in Society, making it a potentially valuable tool for researchers and for decision-makers, who strive for excellence and relevance. It is forward-looking into a number of challenging futures and develops the hypothesis of a European Model of Science in Society which needs further discussion. European research policy will continue to stimulate reflections and debate on the ways science and technology supports developments in our societies, as well as on how the latter integrate and make sense of research. European diversity is therefore an invaluable asset, from which we can all benefit.

I am confident that this thought provoking report will provide a basis for reflection and innovative ideas on the ways European societies interact and shape science in the context of a true European Research Area.

Janez Potočnik

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Executive Summary

The MASIS expert group was asked to examine the role of science in society, basing this on analyses of different trends and challenges, and also taking into account specific areas as visible in the action lines of 'Science in Society' of the Seventh Framework Programme (FP7). What are cutting-edge issues and what are challenging futures?

Europe is undergoing changes, and not only in size and composition. This has also brought new challenges for science in society, not least because it has been given a significant role in the development of EU in the Lisbon Strategy of 2000 and the *Vision 2020 of the European Research Area* (Council of the EU 2009). Citizens have an increasing stake in the European Research Area and in science in Europe in general. This Report examines challenges and cross-cutting issues from a European perspective.

Institutions and practices of science become more and more re-contextualised in society. This is an ongoing process, with overlapping partial transformations, and it is not without contestation. In the end, the question is about an ’adequate’ place of science in society (Chapter 2). There is no simple answer to this question, but it forms the backdrop to the issues discussed in the Report, and leads us to suggest, in Chapter 7, that a European Model of Science in Society may be emerging, even if much diversity remains. Future EU programmes on Science in Society can draw on this, and support its further development.

Other trends include growing interest in strategic research and accompanying institutional changes, greater citizen involvement and science becoming more reflexive about its own role and impacts. Frictions and tensions occur, partly because of these trends. Policy makers emphasise the link between science, innovation and quality of life, but the political dimension (contributions to relevant debates) and the cultural and intellectual dimensions are also important.

The revival of excellence of science as a goal, reinforced by the establishment of the European Research Council, provides an occasion for international competition, and for performance indicators based exclusively on publications in ISI-indexed journals. At the same, there are calls for increased democratization of science, concretely, the involvement of more stakeholders. More stakeholders, and existing stakeholders in new roles, are involved (Chapter 3 gives an overview).

This patchwork of transformations and tensions does not result in a clear picture of an ‘adequate’ place of science in society. In fact, the open debate about the place of science in society should continue, and experiments to address tensions and other challenges should be welcomed.

There are also developments in the governance of science in society (Chapter 4). The governance of scientific institutions is under pressure, not least because of different contexts of governance, simultaneously pushing innovation, democratization and scientific integrity. New forms of governance are emerging: the discourse on responsible development, including attention to ethics and codes of conduct; interactive forms of technology assessment; and experiments with public engagement. Again, these are not without tensions, but they indicate that we do not have to fall back on traditional forms of governance. The challenge is to support ongoing dynamics, rather than containing them, so dynamic governance is called for.

Strengthening Potential (second action line in Science in Society Programme) in the sense of human resources is obviously important, but there are deeper issues. There is the issue of discrimination and empowerment, especially given the continued under-representation of women in many areas of science. Meanwhile, science has seemingly lost its attractiveness as talented young people choose other career paths. Appreciating diversity and making space for including social context can help to strengthen potential. (Chapter 5)

Science communication (third action line in Science in Society Programme) opportunities are increasing. Traditional mass media remains the most important medium for agenda setting, raising awareness and engaging citizens who may not be particularly interested in science. The internet and its use offer easy access to scientific and would-be scientific information. While transmission of information remains important, the challenge remains to develop transaction modes of science communication. A further challenge is the shared construction of possible futures. (Chapter 6)

In Chapters 5 and 6 the general diagnosis of a patchwork of transformations and tensions is visible, such as the need for the debate on the place of science in society to continue, and to have dynamic governance which opens up opportunities for experimentation rather than closing them down. The Report identifies some concrete opportunities to do better. There are differences within the European Union between old and new member states, and cultural differences between northern and southern Europe. The diversity of the EU is an opportunity for further experimentation and learning.

While uniformity should not be the aim, there is the possibility that trends, experiments and mutual learning add up to a European model for science in society (Chapter 7). At the political level, there are distinctively European approaches, but science may be considered to be international. However, the trends towards re-contextualisation and opening up of science to wider publics are visible everywhere in the world. Europe may have come further than other countries and regions, and in that sense it offers an alternative model: not by being different from the rest of the world, but by playing a leading role.

European institutions tend to attribute a more active and creative role to their publics, and as a result, further encourage such social capacity. This will not be straightforward, and explorations and experiments are in order. These should be supported, and also systematically evaluated in order to enable learning. This is where the EU Science in Society programme and its successors can, and should, play a role.

Chapter 1 – Science in Society: Mandate of the MASIS expert group

Science and research are widely acknowledged societal activities within the European Union; many initiatives have been taken to reinforce the role of science in society. The MASIS expert group has been asked to look at the trends, the challenges and the cross-cutting issues related to the role of science in society. Is it possible to talk about a European model for the role of science in society?

Throughout the European Union citizens share what may be called **European values** and some of these values concern science. There is Europe-wide agreement about the value of science for the benefit of society, for the development of the economy and in European research and development (R&D) cooperation. Science and research at the European as well as at the national level are increasingly significant as policy tools in the development of society. The initiative to establish the **European Research Area** (ERA) – emphasising European level cooperation of science institutions and research in a common European area for all research activities – is the political frame in which the role of science in society is discussed in this Report. What kind of role for science in society may the variety of social actors across Europe agree about? Is there something like a special European model for science in society? Is it at all possible to define the 'adequate place for science in society'? Responses to such questions depend on social, political, economic and cultural factors where values and norms play a significant role.

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MASIS aims to map the most significant trends of research and policy activities in the field of Science in Society in Europe

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The Report of the MASIS expert group aims to map the most significant trends in research and policy activities in the field of science in society in Europe. A better understanding of the European landscape will allow a preliminary identification of emerging trends, policy patterns and cutting-edge issues that might require a cross-national and/or European dimension.

The 'Science AND Society' Programme, an initiative of the Sixth Framework Programme, was launched by the EC for the period 2002 to 2006 to develop a dynamic relationship between science and society, considered to be a key factor[1] in the implementation of the **Lisbon Strategy**. The conceptual shift towards looking deeper into the role of 'Science IN Society' (SiS) was presented in the Seventh Framework programme in 2007 where it has set the framework for an inclusive perspective of research in its wider societal and policy context. The aim is to contribute to the implementation of the ERA and to build a democratic knowledge-based society by stimulating a harmonious integration of scientific and technological endeavour in Europe via the encouragement of broader public engagement. To address the challenge, national stakeholders and the EC programme are engaged in a joint effort to link SiS-related activities with policy developments across Europe and to achieve complementarities and greater coherence.

[1] The aim was to 'develop the means for more constructive and effective communication and dialogue between research and citizens in general, so as to enable society at large to have a better-informed and more constructive influence on the future development and governance of science, technology and innovation' - Council decision (2002/835/EC).

‘Science in society’ has a double meaning. On the one hand, it is an FP7 Programme linked to a vision of stimulating the harmonious integration of scientific and technological endeavour in Europe, which the report refers to as SiS. On the other hand, it implies issues of science in society as they have emerged over the last decades and are now on the agenda in the EU and in member states, whether they are part of the SiS programme or not. Such issues include governance, communication, social and ethical questions around science.

In order to interpret its mandate, the expert group has discussed whether the report should use the broad or narrow concept of science. In the SiS context the notion of science is primarily associated with natural sciences, and to date there has been less focus on social, economic and human sciences. This report will nevertheless use the term ‘science’ in its broadest sense, as in the German *Wissenschaft*.

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The key point is that the various developments and issues are not seen as separate. They are part of an overall move toward further re-contextualisation, one where authority (about valid knowledge) and monopoly (on doing scientific research) of established institutions are relaxed; some would say undermined.

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The **title ‘Challenging Futures’** is supposed to demonstrate the need to examine always issues from different angles. At first glance, the title may suggest that the report will challenge existing images of the future, and indeed, it will do so in some instances. But at the same time the title indicates that the future of science in society will be full of challenges.

Changing boundary conditions for science-as-we-know-it, derived from changes in the surroundings and the context are strongly correlated with the dual problem of an autonomous science at a distance from society. The role of science in society is under re-contextualisation and it is being re-contextualized. The term ‘**re-contextualisation’** implies a strong problem definition of an earlier autonomous science: if bridges with other social actors are built (which should be built), this can then be experienced as undermining the autonomy of scientists. The key point is that the various developments and issues are not seen as separate. They are part of an overall move toward further re-contextualisation, one where authority (about valid knowledge) and monopoly (on doing scientific research) of established institutions are relaxed; some would say undermined. This overall move is contested so there are attempts to (re-)define ‘core science’ (which should then regain its ‘adequate place’). This is also the overall perspective from which the report identifies groundbreaking science-in-society studies in Chapter 2.

One of the major trends in the field is increased public-private interaction and an increase in the strategic use of science even within publicly-funded research. The reinforcement of increased interaction among researchers at universities, other government affiliated research institutions, private business and enterprises is a central element in the re-contextualisation of science in society.

The broader involvement of actors and, consequently, the **increased number of stakeholders** involved in science has challenged the role of science in society and the traditional academic freedom of researchers. The role of scientists has also changed. Chapter 3 outlines the variety of social actors or stakeholders who have an interest in research and especially in the role of science in society. At the same time, it highlights the challenging futures of science in society, with numerous stakeholders being just one aspect of the changing boundary conditions for science. Another issue related to stakeholder variety is the potential for fruitful cooperation or the potential for conflicts and competition among the increased number of both public and private stakeholders. Commercialisation is a result of changes in the logic among dominant stakeholders. The nation state is traditionally a strong stakeholder, responsible for establishing the public science system and the primary funder of basic research, but it now wants more strategic research, more commercialisation to support innovation and more cooperation between private enterprises and public knowledge-producing institutions. Meanwhile, the increased involvement of civil society organizations in research policy processes induces new forms of governance (Gall et al. 2009).

Some issues within this analysis of the role of science in society are so broadly cross cutting that they are dealt with at a general level in Chapter 2. Other issues are clearly attached to specific action lines of SiS and they are dealt with in specific chapters. In this way cutting-edge issues attached to developments of governance are presented in Chapter 4, which also raises the discussion about challenging futures due to new forms of governance. Science, democracy and law are central elements in SiS, but how are these elements influenced by more dynamic governance of science-society relations? Democratisation of science is requested by many and the role of the nation state is challenged. What can be done by law? What can be done by providing better frames for deliberative democracy?

Is the **role of law** diminishing due to the increased free market for science and research-based products? What are the implications for traditional academic freedom for scientists at universities? The growing commercialisation of scientific research results has put the issue of intellectual property rights on the agenda. How can we deal with controversies, such as ownership of property rights. These are some of the cutting-edge issues attached to governance.

While gender issues and the importance of young people are high on the science policy agenda, there remain many other open questions on how to ensure that the diversity of the European Union is reflected and utilized in science. The trends and issues of strengthening potential are discussed in Chapter 5.

Will science communication effectively rise to the challenges posed by numerous stakeholders and the internet age? How will communication between diverse actors evolve in science? Chapter 6 addresses the cutting-edge issues of science communication in detail.

What are the challenges to the role of science in society? Can we find European answers to these questions? What is the specific European character? Is there something we can call a European model of Science in Society? Chapter 7 examines the European-level development of SiS policies from an international perspective.

The implementation of the *2020 Vision for the European Research Area* (Council of the EU 2009) is perceived as a process that ensures the coherent development of policies and measures at the EU and national level, which contributes to the full realisation of the ERA, the Lisbon Strategy and the implementation of the Ljubljana Process announced in 2008. The analyses provided in this report can be considered as an input to this process.

Chapter 2 – The place of science in society

In his January 2009 inauguration address, US President Obama said he would 'restore science to its rightful place', and thus framed a general issue: what could and should be the 'right', or at least adequate, place of science in society? At the same time, he suggested that science had, at one time, occupied its rightful place, to which it should be restored. That message is not only historically incorrect, but politically inopportune. Instead, we should look forward, and ask what might be a 'good' or 'adequate' place for science in society, given the ongoing changes and the way they are being evaluated. An explicit answer to such a broad question includes a normative orientation, a model of society, an idea of democracy as well as an image and understanding of science including its societal mandate and its limitations. While there have been, and continue to be, attempts to address this question as such, the important point is that in the views of scientists, policy makers and societal actors, as well as in actual policies and responses to science, an implicit idea about the 'right' place of science in society is embedded. Answers to this question will neither be simple, nor will they go uncontested. But this is how it should be: as the relations of science in society are fluid and evolving, so debates about it should remain open. For that reason alone, in this report it is important to consider the place of science in society, as well as its appropriate place.

2.1 What is the place of science in society?

Earlier discourse on 'Science ***and*** Society', and related notions like **a social contract** between science and society, assume a distinction between science and society and then attempt to bridge the gap. But phrased this way, it is a self-constructed gap. On the one hand, there are certainly differences between science and other systems of action, interaction and communication in society, but science is not outside society. On the other hand, over time, a relatively autonomous science sub-system has emerged and is reproducing itself, including a strong inward-looking orientation coupled with equally strong convictions about the contribution of science to enlightenment and progress. This is how the place of science in society is often seen from within science.

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The adage that science is too important to be left to scientists captures the normative challenge of integrating science in society, allowing for societal participation, but in such a way that its creative power is not subsumed by immediate interests.

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While it is historically correct that some independence and separation has emerged since the 19^{th} century, this is not to say that it has to continue that way – no need to 'restore' science to whatever place is projected as 'rightful' – and there are normative considerations about the links between science and/in society. It is also historically correct that science was never separate, and that the present move towards re-contextualisation (see Ch. 2.2) is predicated on a variety of long-term and ongoing interactions. Studies in science, technology and society have contributed to our understanding of this point, and we shall briefly mention a few key studies that have had a lasting impact.

Science, in the way it shapes our views of the world, of ourselves and our societies is an important force. Its insights also fuel controversies, as such, or when linked to applications (e.g. debates on human enhancement, climate change, stem cell research, geo-engineering and, just emerging, synthetic biology). Science also enables innovative products and ways to improve quality of life. The adage that science is too important to be left to scientists captures the normative challenge of integrating science in society, allowing for societal participation, but in such a way that its creative power is not subsumed by immediate interests.

The other main normative challenge starts with the observation of Sheila Jasanoff that 'the sound conduct of science and the sound conduct of democracy both depend on the same shared values' (Jasanoff 2009). There is a wish list of such values: commitment to reason and argumentation, transparency with respect to judgments and decision-making criteria, openness to critical scrutiny, scepticism with respect to unquestioned dominant values and positions, willingness to listen to different and countervailing voices and to check their argumentative validity, readiness to admit uncertainties, respect for the best available evidence even if it is constrained with uncertainties, mistrust of unquestioned authority, high attention to issues of legitimization and justice, and equity in communication situations. The challenge for science as well as for democracy is how to uphold these values in practice, and how they can support each other in doing so, even while their actual arrangements are very different (e.g. laboratory work versus voting in elections).

Among the attempts to offer an empirically supported diagnosis of an 'adequate' place of science in society, a few earlier publications stand out, and can in fact be seen as groundbreaking studies for any discussion of science in society.

Michael Polanyi (1962) articulated important features of what he called the **Republic of Science**, justifying its relatively autonomous place in society in terms of the inner workings of this Republic. While his article was also part of a longer debate (in the UK) about freedom of science, his analysis was fruitful in its own right, as is clear from recent studies showing how institutions of the Republic of Science are changing (Rip 1994) and how a new political theory critical of Polanyi's Republic of Science is necessary and possible (Fuller 2000). Polanyi's analysis is explicit about the mandate of science, and subsequent discussions of his ideas thus also allude to, or discuss, this mandate. One example is Weinberg's (1963, 1964) influential articles on criteria for scientific choice (see also the collection of articles published by Shils 1968).

Another key contribution at the time, outlining how science works and is necessarily embedded in society, but also offering criticisms of specific interactions and pressures, is the book (and subsequent activities) of Jerome Ravetz (1971). These writings were very influential in the 1970s, and he continues to be an important commentator on evolving issues of science in society, e.g. with the diagnosis of post-normal science (see Funtowicz and Ravetz 1993).

In a sense, the late 1960s and early 1970s were critical for science-in-society: activities and views changed (e.g. the call for relevance of science) and **studies of science-in-society** emerged as a field in its own right. Another critical moment emerged during the 1980s, which saw the beginning of strong policy interest in the value of science and technology for economic growth and quality of life, and a variety of measures and changes in the conditions for scientific and technological research. Bruno Latour's (1987) book, *Science in Action*, makes the workings of the new techno-science explicit. He has said that he was just synthesizing the achievements of the field of science and technology studies, and while he did much more, it was definitely the synthesis character of the book which made it a landmark study.

When Michael Gibbons et al. (1994) introduced the idea of 'Mode 2' knowledge production, they were diagnosing the same changes, and adding a strong vision about 'Mode 2' being both desirable and imminent. This claim has made their book an attractive reference for scholars and policy makers, and has been fashionable in science policy, similar to the attention given to Big Science in the 1960s and 1970s (Rip 2000).

All these studies engage with the problem definition of an autonomous science, at a distance from society, which is now re-contextualising and being re-contextualised. In Ch. 2.2 below we develop this line of thought. Here, we add that since science and technology have validity and performance somewhat independent of context, one can approach and study them as such, follow their development even when contextualising it. This is not reverting to the idea that somehow the internal workings of science are its rightful place, in the sense that rights can be derived from it. It is a recognition that the so-called internal workings of science are an integral part of science in society.

2.2 *Ongoing partial and contested transformations*

As was noted in Chapter 1, the term 're-contextualisation' appears to imply that earlier there was autonomous science, at a distance from society, that is now being re-contextualised. While there is some truth to this diagnosis of what is happening, analytically it is better to use the open-ended concept of 'transformations'. Re-contextualisation is then one of these transformations, but there are others. We shall discuss the emergence of a regime of strategic science, and a general move towards reflexivity, also visible in the emergence of the new field studying science and its impacts.

2.2.1 Re-contextualisation of science

Since World War II, and with the experience of the war efforts to which science contributed, a new regime of science in society emerged, sometimes called **'Science, the Endless Frontier'**, after Vannevar Bush's report to the US President in 1945. The regime included a strong division of labour, with public research institutes devoted to missions of societal relevance, and universities being funded for basic research, without any questions asked about relevance. From the 1960s onwards, this regime came under pressure, in parallel to national science policies becoming more active. The regime opened up to new policy instruments, for example strategic research programmes; and public scrutiny became important, including more accountability as well as links with various publics. By the 1980s, the earlier regime 'Science, the Endless Frontier' was giving way to a new regime which could be labelled 'Strategic Science' (see Ch. 2.2.2).

What kind of role do national governments and European governing bodies want science to play in society? What kind of conditions frame science? What kind of institutions are needed? How can they respond to societal changes?

While parts of the older contract between an autonomous and separated science and society survived (especially as a self-perception of scientists and as cultural views of science), the contract was opened up in recent decades. By the 1980s, outlines of a **new social contract** appeared, and one input was the recognition of new modes of knowledge production. Traditional truth-searching scientific knowledge production was opened up towards involving social values under the notion of

***relevance* of science**. Programme-oriented funding was (and is) a major expression of these new forms of knowledge production that are classified as 'strategic research' (see Ch. 2.2.2).

The old division of labour between fundamental and applied or problem-oriented research has almost disappeared, and with it, the functional distinctions between universities, public labs and industrial and other private research. In its place came the fluidity of a transitional stage, but also emerging new patterns. The so called 'technosciences' (Latour 1987) are well-known examples. A new exchange space and market for knowledge has been formed where all these actors compete and cooperate in various configurations.

The emerging lock-in into the regime of Strategic Science was pushed, in the 1980s, by the interest in scientific technologies as a motor for renewed economic growth. While this motivation is still in place, there is a second component as well, the interest in long-term developments about which decisions must be made now, and which require new kinds of scientific input (Schomberg 2002). Climate change is an obvious example, and more generally all the many activities towards sustainable development and sustainability science.

Gibbons et al. (1994) and the sequel by Nowotny et al. (2001) emphasize a number of changes which in their view add up to a **Mode 2 of knowledge production** in a Mode 2 society. Mode 2 is characterized by fluidity, changing research teams, distributed research more generally; discovery in the context of application and transdisciplinarity leading to the declining relevance of traditional disciplines; new forms of quality control as the 'extended peer review' proposed by Funtowicz and Ravetz (1993); contested expertise and (social) robustness as the new ideal. The result, as they conclude, is the needed re-contextualisation of science (in society).

Clearly, there are ongoing transformations in the science system itself and in its relations to and in society. The strong suggestion of Gibbons et al. that Mode 2 is better, full stop, is too simple. We see tensions and frictions at work, controversies and also counter-movements (see Ch. 2.3). The transformations are partial and contested, and there is no one-dimensional development. Parallel to the continuing trend towards re-contextualisation, there is also a reaffirmation of core science under traditional notions of 'excellence'.

2.2.2 Strategic research and a regime of Strategic Science

While the term 'strategic research' was used already in the 1970s to denote applied research with a long-term perspective it has now become a type of basic research. In some fields like biotechnology and chemistry, and some areas of social science, strategic research covers most or all of the research that is done. Programme-driven research dominates these fields, and the programmes include some ideas on what science and research should achieve against the background of societal problems and expectations. Traditional undirected research does not disappear, but is increasingly integrated into programmes of strategic research.

Strategic research combines *relevance* (to specific contexts, possibly local) and *excellence* (the advancement of science as such). The contrast between fundamental (and scientifically excellent) research on the one hand and relevant research on the other hand is not a contrast of principles. It has more to do with the institutional division of labour than with the nature of scientific research. The combination of scientifically excellent and societally relevant research occurs again and again, in history and in present-day science (cf. Stokes 1997, Rip 1997). This combination is not present in all disciplines and scientific fields in the same way, but it occurs often enough to justify the claim that a new category like strategic research that embraces both is a realistic option.

The (by now) authoritative definition of Irvine and Martin (1984) brings this out well, and indicates further important features: '*Strategic research [is] basic research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognized current or future practical problems.'*

Thus, a distance is created between ongoing research and the eventual uptake of its results by emphasizing expectations, the production of a 'base of knowledge', and the provision of a background to problem solving rather than offering solutions. Often this happens by referring to futures and visions which relate far-ranging future expectations with today's scientific agenda (e.g. in the fields of nanotechnology and human enhancement). In this way research is done according to strategic and societally relevant goals but without being fixed to certain endpoints such as delivering real products. The openness of scientific research is maintained in spite of its strategic nature. Scientists have internalised the pressure for relevance, but maintain the open-ended character of their research, with the attendant freedom to move to other, more promising lines of research.

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Instead of a linear model of innovation (and attendant policy measures and expectations of immediate benefits), one could speak of a lateral model of innovation, where innovations and their effects on wealth creation and quality of life are not limited to a linear chain of innovation.

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Research results thus contribute to a *reservoir* of scientific knowledge and technological options, while others fish in the reservoir and create new combinations (which range from new understanding to new technological options, innovations and expert advice). The reservoirs are visible in the contents of scientific and trade journals, but professional networks are equally important. Such reservoirs are carried and maintained by hybrid communities (see Ch. 3). Examples of this abound in fields like nanotechnology and biotechnology.

Instead of a linear model of innovation (and attendant policy measures and expectations of immediate benefits), one could speak of a **lateral model of innovation**, where innovations and their effects on wealth creation and quality of life are not limited to a linear chain of innovation. Some of the more interesting innovations and their impacts derive from new, lateral combinations, and the social and intellectual mobility of key actors. This applies to innovation-oriented research, as well as to expertise and decision-oriented strategic research. Life sciences and technologies such as nanotechnologies are linked to innovation, as well as to insight and expertise, and thus straddle these two components of the regime of Strategic Science. Environmental and earth sciences, most social and behavioural sciences are primarily linked to the second component, strategic decision making (e.g. against the background of the Precautionary Principle).

Institutionally, an important indicator of the increasing importance of strategic research is the spread of centres of **research excellence and relevance** and the increasing share of strategic programme research. The US Engineering Research Centres, the UK Interdisciplinary Research Centres, and the Australian Collaborative Research Centres all started in the 1980s, and by now, such centres have been established throughout Europe. In the Netherlands, in the Scandinavian countries and in Germany large parts of public research funding are currently organized as strategic research, frequently in the form of research programmes dedicated to societal problem solving.

Less emphasized, until recently, is the importance of expectations, i.e. promises about what the research will mean. Voicing promises has become an integral part of the research endeavour, and this has led to concerns (by scientists) that there may be too much hype, which would lead to disappointments, and thus to a backlash in public appreciation of, and political support for, new science.

2.2.3 Reflexive Science

Society is now less fatalistic about the impacts of science and attendant risks (as with molecular biology and genetic modification), and wants some technology assessment (TA) and ethical reflection done. This will influence **innovation-oriented research** and will have an impact on the governance of science ('responsible development'; see Ch. 4.2.3). Society also wants expertise (up to 'sound science') even in the face of large uncertainties. Expertise is not limited to what regular science provides. New stakeholders are becoming important at all levels of the research system (see Ch. 3). Public observation and scrutiny of science is now a fact of life. It has to do with public understanding of science, but more importantly, with new interactions in the risk society, including a critical appreciation of experts and expertise.

One further effect is that science has to reflect on its role in and impacts on society. This is not only a philosophical exercise, but also contributes to the development of new research fields such as risk studies, impact studies, Technology Assessment, STS studies, and applied ethics. While these are fields of research in their own right, they are now also integrated in programmes of research, as for genomics and nanotechnology (see further Ch. 4.2.3). Thus the entire science system is becoming more reflexive regarding its nature and societal contexts. We consider this to be an essential step in realizing science *in* society.

Two examples. In the ongoing **debate on human enhancement** many new questions arise, ranging from ethical ones of how to deal with the increased use of pharmaceuticals for enhancement purposes in daily life and in sports to far-ranging philosophical questions about human nature, and future relations between humankind and the environment. This debate is triggered by new developments in science (e.g. Nano-Bio-Info-Cogno and other types of convergence, Roco and Bainbridge 2002, Nordmann 2004). Beyond ethical considerations at the individual level, there are also questions about how society will evolve – into an 'enhancement society'? Science-in-society activities such as public engagement will be needed to mediate between public attitudes, stakeholder positions and scientific interests. This is one sort of 'reflexive science' at work.

A second example is about the increasing importance of scientific expertise for decision making under possibly extremely high uncertainty (Grunwald 2007b). The resulting **pressures for 'sound science'** and rational decisions require further skills, at least for some researchers. They must be able to provide expert narratives linked to (societally) robust evidence (cf. also Nowotny et al. 2001). In epistemological terms, reflexive science does not only provide knowledge but also meta-knowledge: knowledge about knowledge, for example about premises, conditions of validity, uncertainties, areas of ignorance, values and conditions of applicability to certain contexts (Grunwald 2004). Involving publics, one component of re-contextualisation, can be more productive if not only the knowledge at the object level is presented and discussed, but also the related meta-knowledge.

Reflexive science is not the endpoint of a transformation but a continuous process of observation, reflection, reaction and adaptation. Reflexive science opens up ways to go forward.

2.3 Tensions and frictions

The place of science in society is not given, and the question of its proper place will be debated and contested. This is as it should be, because tensions and frictions are an integral part of ongoing transformations, and actually provide opportunities to explore the nature and further evolution of science-in-society. We discuss a number of tensions and frictions, without claiming to be comprehensive; these will be detailed in subsequent chapters and further tensions will be added.

2.3.1 Uses of science in society

Providing knowledge for innovation and the economy is an essential aspect of the place of science in society. There are other uses of science, however, for example to contribute to quality of life (this terminology is common in the UK). It is probably better to speak of 'dimensions' along which the role and use of science in society can be appreciated, rather than of 'uses'. We distinguish five main dimensions:

- *the innovation dimension*: ensuring economic competitiveness in the global marketplace, providing innovation and contributing to wealth, and economic growth;
- *the quality of life dimension:* contributing to health, education, welfare, and a viable social order;
- *the political dimension*: contributing to relevant debates, especially concerning future developments involving science and technology, as well as giving expert advice to policy makers and the public;
- *the cultural dimension*: respecting cultural diversities, conserving cultural heritage, developing communication skills and intercultural dialogues;
- *the intellectual dimension*: thinking about a 'good society', the future of human nature and sustainable development, contributing to the quality of life.

This view on the dimensions of science in society has specific consequences for strengthening scientific capacities (Ch. 5) and for science communication (Ch. 6).

2.3.2 Cultural diversity

The well-known diversity across European regions and countries shows itself not only in customs and lifestyles but also in different and diverse traditions in science systems. For example, the roles of the academies of sciences, the structure of universities, attitudes toward whether and how to involve the public in science, career modes, gender roles and equal opportunities polices, and positions about the 'adequate place' of science in society are just some of the variations in the European landscape of science. This cultural diversity, understanding European science as an ensemble of different scientific 'cultures', can easily be found by going through the various European regions. We find different ways of organising research in **different ’research cultures’**; and since there are different ways of integrating science in society we can use the term ’science in society cultures’. There are different cultures from west to east, from north to south, between old and new member states, depending on history and traditions. The absence of a common understanding of science in society issues at the European level, similar to the absence of a European citizenship as a common identity.

These cultural differences are, on the one hand, a challenge for European unification and for further steps towards a European citizenship concerning science in society issues. On the other, this cultural diversity can be (and should be!) regarded as richness. (Ch. 5.3.3) It offers the opportunity for experimenting with different forms of science in society relations in different cultural settings, and for mutual learning from the experiences. It allows the possibility of making use of a 'civic epistemology' (Jasanoff 1990) which influences assessments of knowledge by giving criteria of relevance and importance and orientates the design of procedures for how knowledge is to be assessed. Co-production of knowledge in culturally different 'science in society' systems can take place in different forms, according to different cultural backgrounds.

However, to exploit these opportunities, it will be necessary to establish activities across the existing scientific and science in society cultures. There are already successful examples of bringing researchers together in the ERA, by many projects across many European countries. In this context, the ERA can be seen as a specific location for the re-contextualisation of science, as a location where many experiments take place allowing learning by combining and comparing experiences. As we show in Chapter 7, there are some indications that the search for an adequate place of science in society in Europe has led to some specific European approaches which justify speaking of a ‘European model’ of science in society.

2.3.3 The revival of 'excellence'

The revival of ‘excellence’ was already visible around 2000, and it was reinforced by the establishment of the European Research Council with its mission to support excellence, and the German Excellenz Initiative. The continuing **emphasis on publication indicators** (and ISI journal publications) in assessments and evaluations also strengthened this revival. While we have shown that relevance and excellence are compatible (Ch. 2.2.2) there is a serious question whether a one-sided and strong emphasis on excellence, or the choice of specific indicators for measuring excellence, will endanger the pursuit of relevance.

A case in point is the increasing importance of the ISI impact factor system which favours de-contextualised and globalised science while context-related and more local research, dedicated to specific problem solving, is disadvantaged. Sciences could lose their link to practice resulting from the pressure to publish in international journals instead of engaging in local environments and problem solving. Thus there is a (perhaps unintended) tendency to bring science back to a more separated, perhaps isolated and more autonomous activity, following its own rules and hunting for impacts in the ISI system rather than in the ‘real world’.

Of course, for science to be relevant it must be good science. The idea of excellence, however, relates to being better than others in some competition, rather than being good. Research teams must be able to combine problem-solving capacities at a context-bound level and at a more general theoretical level – which also leads to new requirements for education and management.

2.3.4 Democratization of science?

Democratisation is a continuous challenge to modern societies (Barber 1984). While in former times, democratisation meant simply the change from absolute or moderate forms of monarchy or dictatorships, now democratisation is something which is asked for and which has to be achieved within societies already organised in more or less democratic ways. Democratisation in Europe is frequently used both as a slogan for reforming the European Union itself, and for dealing with science in society issues in a democratic way. Particular challenges in this respect occur (a) at those points where political institutions meet decision-making needs concerning science issues, and (b) in all approaches to involve the public beyond representative democracy. Both challenges are relevant for shaping the European knowledge society in a democratic way. But what does this mean in practice and how could it be achieved?

We identify two main issues in the move towards democratic participation.

First, should every citizen be regarded as a stakeholder concerning science, e.g. in determining **research agendas,** and perhaps also in evaluating the value of research findings? An affirmative answer evokes the spectre of deciding about scientific issues by popular vote. On the other hand, there is no good reason to exclude citizens from deliberation about the direction and value of science. This is a governance issue to which we return in Chapter 4. Here, we point out that attitudes of scientists, linked to an earlier regime in which they were protected from society, may confound a productive approach to these questions.

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There are two different forms of governance in this field: via democratic institutions at the political level and in the marketplace via new constellations of engineers, scientists, users and citizens. Both forms have a role to play, but their rationales are different.

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Many scientists and science managers regard the public (as well as politicians) as irrational and not able or willing to understand or engage in sound argumentation. This can go as far as natural scientists and engineers seeing society as a kind of enemy, as a creator of problems to scientific advance, as a source of regulation and prohibition rather than as a partner in a common process shaping future issues involving both scientific advance and societal issues. From such an attitude, re-contextualisation is seen as something forced on science, rather than as a challenge to do better. Current initiatives at public engagement are already seen as going too far, and autonomy should somehow be restored.

While every citizen might be regarded as a stakeholder in science for normative reasons, it does not imply that he or she should actually be asked, or have the right, to participate in the workings of science. Thus, there is no reason for the defensive reaction of scientists that we just described. What is important is to experiment with ways of interaction, and evaluate where they might lead.

The second main issue for **democratic participation** starts with actual practices. There appear to be two completely different places for involving 'the public': (a) in identifying the 'public interest' and orientating the boundary conditions for science and technology, and (b) involving real actors, mostly users, in shaping real technology (products, systems). Thus, the notion of 'participation' has a double meaning. While initially it was an issue in theories of democracy, claiming a renewal of the more formal representative democracy and enriching it by forms of a deliberative and interactive democracy, it is now also used to describe the involvement of users in the shaping of specific technologies which would be sensible in many cases but does not have much to do with political democracy. Public participation loses its traditional and emphatic connotation of deliberative democracy and becomes more and more a means of involving users in the design of new products, driven by economic rather than political needs.

We are not arguing for or against one or other form of participation, but we are highlighting that there are two different forms of governance in this field: via democratic institutions at the political level and in the marketplace via new constellations of engineers, scientists, users and citizens. Both forms have a role to play, but their rationales are different.

2.4 In conclusion

We are not in a position to pronounce upon the adequate place of science in society, although we have made a number of claims (and sometimes strong claims, when we criticized attempts to restore the autonomy of science) to that extent. These claims were part of an overall diagnosis of ongoing transformations, the tensions and frictions in them, and the challenges and contestations that go with them. As such, they are part of the **ongoing debate**, rather than an attempt to close it. That is perhaps our main message: it would be premature, and perhaps unwise in general, to go for closure (Stirling 2008). This is not to say that we should not try to find practical solutions to the tensions and challenges, but that we should remain open to alternatives and to lateral moves.

Chapter 3 – Social actors as stakeholders

As the previous chapter revealed, the context of science in society has changed to a large extent. Not only does science influence society but society also has a growing influence on science in different ways: by re-contextualizing, by ethicisation or simply by advocating democratization. But what is society? What are those constituencies with which science interacts? In order to provide an answer to this intriguing question, in this chapter we map the stakeholders. It is also important to reveal the driving forces that make stakeholders show interest either in research or in science policy or in an SiS programme implementation, or all of the above.

As contemporary policies are increasingly embedded in the concept of the knowledge society, the effective development, management and deployment of knowledge and research are becoming key components. This reflects the ambition that it is essential for the overall development of modern societies to integrate the principles of a knowledge society at a policy level. Consequently, the policies for these areas have to shed their traditional character as only affecting and involving a relatively narrow range of stakeholders and experts. Knowledge and research are too important to be left to the experts alone, issues of public interest are at stake, and research activities need to be justified and shaped in compliance with publicly voiced interests.

Due to the re-contextualisation process described in the previous chapter, science started to 'reach out' to society, involving more stakeholders as a consequence. Also, due to the democratization of the field, some actors who have so far been passive have started to show growing interest in science, especially in the governance of science. All in all, this results in a proliferation of stakeholders.

This chapter aims to provide an analysis of stakeholders: first to identify the stakeholders of science in society, and second to describe their motivations. We provide an overview of stakeholders' possible concerns before presenting the trends and the challenging futures of dealing with these groups.

3.1 What is at stake?

A stakeholder is any person or organization that can have an effect or be affected in a certain context. In the context of science in society, stakeholders are defined as those having something at stake in the interplay between science and society. This definition requires the analysis of what motivates different stakeholders to engage with science and research.

At times when negative attitudes arise regarding new technologies (e.g. GMO, nanotechnology), stakeholders in the business sector (e.g. medical and food producing companies) become concerned about future earnings and the potential loss of promising research investments. However, stakeholders do not have only economic concerns.

In the science-in-society context, **moral and ethical concerns** of stakeholders are major driving forces for their involvement. These concerns, often based on religious and political views, are voiced especially by religious organizations and non-governmental organizations that address human rights.

Other stakeholders are more concerned about the **quality of life, health or the environment** which are perceived by some as being open for debate due to developments in science and technology, especially in the context of medical experimentation. Patient organizations, environmental NGOs and nature conservationists are typical stakeholders of this type, actively participating in public discourse on science.

For governments, quite often the motivation for acting as stakeholders in SiS programmes is **political prestige**, especially after the Barcelona Agreement (COM 2002), which set the required level of investments in R&D as a percentage of GDP. Those countries not being at or near the necessary level have been losing prestige, and a number of member states across Europe are trying to reach the target by 2010.

The motivation for schools and universities to participate in SiS programmes is always two-fold. Partly, they are concerned with the issue of science, and partly **education and educational investments**. This latter dimension has not been central on the agenda, even though it is highly interconnected with science and science-based education, especially at the university level.

3.2 Stakeholders in SiS: Who are they?

According to organizational theory, without the support of stakeholders organizations would cease to exist (Freeman et al. 1983). Stakeholder theory was developed by Freeman in the 1980s and the concept has now gained wide acceptance in theorizing related to strategic management, corporate governance and corporate social responsibility. The word 'stakeholder' has become commonly used to mean a person or organization that has legitimate interests in a project or entity.

In principle, every person in society is a stakeholder when it comes to the role of science in society; therefore, the term social actors might be more relevant. One problem with this concept is that not all of these actors are active. (cf. Ch. 2.3.4) Citizens are the equivalent of customers in the original theory of company stakeholders, because, overall, scientific developments have an effect on the life of everybody in the society. Citizens' engagement in a broad sense has been on the agenda of the European governance debate for several years, and a series of experiments with different forms of public involvement has led to great expectations about the involvement of engaged citizens.

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Most stakeholders in science also do research themselves. Universities, governments, industries and even interest groups not only benefit from research, but also actively engage in science, often directly or via organizations established for research purposes. Examples are government research centres, company departments of research, and think tanks.

Stakeholders of science-society interactions are very diverse, and while universities and research communities interact, government as well as industries influence the research agenda at research institutions. It can also be observed that stakeholder groups are becoming increasingly interconnected, undertaking each others' roles, jointly engaging in scientific activities, etc. In the process, the boundaries between stakeholder groups are blurring. Major stakeholders and their relations are outlined in *Figure 1*.

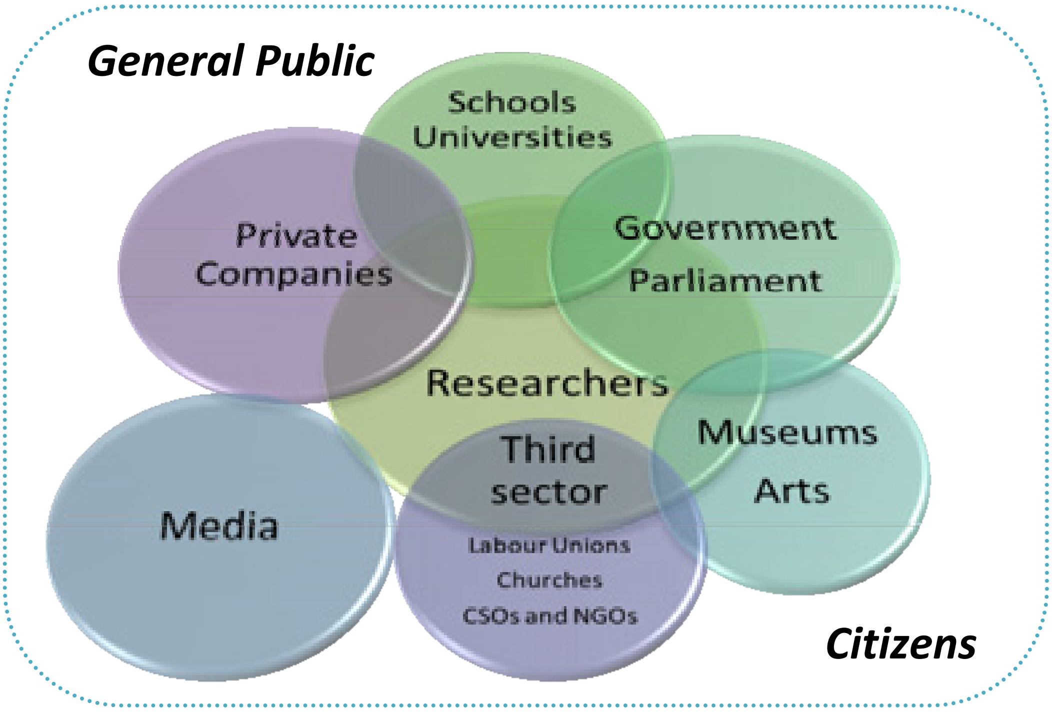

Figure 1: *Overlapping systems of stakeholders and social actors active in research*

Researchers and Academies

In reality, some stakeholders are more involved in research than others. Obviously, **researchers and research organizations** are among the most directly involved, without whom there would be no science at all. Even though within the context of the above definition they are considered as, and also perceive themselves as the prime stakeholders, only a limited number of researchers participate in science and society interactions as individuals. Usually, associations or some other form of collective, like a formal institutional organisation with all heads of universities or distinguished researchers on its board, participate in public debates across Europe.

Academies of science are directly involved in research: some academies formulate science policies and actively participate in public debates and some have research institutes. ALL European Academies (ALLEA), among its other aims, seeks to offer European science and society advice from its member academies. In past years, there have been discussions in many academies about the need for reforms to attract more young members and to increase the proportion of women in the membership as well as in leadership positions. For instance, The Royal Netherlands Academy of Arts and Sciences established the Young Academy to include young scientists who obtained their doctorate within the preceding ten years. Thus, it may be expected that the ongoing transformation of academies will enhance their participation in European science policies.

Schools and universities

This group of stakeholders traditionally plays a key role in the second action line 'S*trengthening potential'* of SiS programmes, discussed in Chapter 5. Nevertheless, educational institutions are active in communicating science, and have a fundamental role in the democratization of science.

Universities and **higher education institutions** are established stakeholders of science in society, partly due to their role in research, and partly by representing science-based educational institutions. Universities have gradually become stakeholders that advocate more resources in higher education in order to enhance the quality of science education. Recently, they have also raised arguments for more academic freedom.

Primary and high school teachers and their representative associations are important stakeholders of the science in society field, especially when it comes to science education and popularization of science. Moreover, their role is also central in communicating equity and ethical aspects of science.

Students of all educational institutions are directly exposed to science and the use of scientific results. This large group of stakeholders is crucial in all areas of the 'strengthening potential' action line, as well as in the interaction between science and society in general.

Nation states, governments and parliaments

Traditionally the responsibility for providing national science institutions and the responsibility for providing funding and capacity for public research has belonged to national institutions. In Europe, this has primarily been an area of responsibility for **the state.**

Governments – science policy makers, responsible ministers, the European Commission and local governments alike – have very great expectations and very much at stake in science and society interactions. Science and research policies are formulated and evaluated at all levels from the local, the regional, the national and the European in ever-growing numbers. The **European Parliament**, the European Commission and recently the European Research Council have all become increasingly prominent stakeholders in SiS, and they too demand evaluations and ongoing analyses of competing stakeholders.

Ministries of Science are predominant in science policy, announcing their plans for research policy and arguing for investments in R&D to be the means to national and European economic growth. Thus, ministries in most countries actively participate in public debates and maintain regular contacts with the media due to their interest in the impact of their initiatives and concerns about their status in a European context.

The government also influences science in society via the allocation of funds for research activities by **funding agencies**. All over Europe, the agencies traditionally work at the national level. For many years, the DG Research of the European Commission has acted as a funding agency by implementing the **Framework Programmes**, and thus has also become a crucial stakeholder in SiS.

Political parties in most European member states have been proposing more or less specific plans for investments in science institutions and argued for increased investment in research activities.

Private companies

Industrialists and industrial associations are very active stakeholders in the science-in-society arena. Associations often consist of big industrial corporations. Their members may also be active as individuals in public debates on research policy, providing inputs to newspapers and special reports with recommendations for new policy initiatives. The main issue for this group of stakeholders is the need for increased cooperation, communication and use of research produced in public research institutions like universities by private business and industries.

The role of industrialist stakeholders in science has gained importance at the European level after the Lisbon Strategy (2000) and especially after the Barcelona Agreement (COM 2002), when private companies across Europe were urged to increase their investment in research to at least two percent of national GDP by 2010. As a result of these developments, companies often engage in cooperation with public research institutions.

Recently, smaller private companies and even **small and medium enterprises** (SMEs) are recognized as stakeholders of science in society, as their potential in research and innovation is gaining importance in the building of the 'knowledge society'.

Some **interest groups**, for example national industrial interest organizations, have become such important stakeholders that they are allowed a seat on decision-making committees. Moreover, since private research funds are increasingly gaining significance, they sometimes set the agenda of discussions. At EU-level decision making, European Technology Platforms and Social Platforms are newly introduced processes to involve stakeholders in defining research agendas.

The Third Sector

Describing the diversity of stakeholders' groups is most difficult in the case of nonprofit organizations. The Work Programme (2009) gives the following definition of CSOs: '*nongovernmental, non profit, not representing commercial interest, pursuing a common purpose in the public interest'.* In our effort to map the stakeholders, we use the term 'third sector' as an umbrella term for various interest groups of citizens, such as civil society organizations and labour unions, as well as religious organisations and informal networks of citizens. The reason for this classification is that these groups are distinguished from other stakeholders by their motivations. As opposed to the stakeholder groups discussed so far, the organisations of the third sector are often involved in science in society activities either due to moral, ethical and ideological concerns or in order to represent certain interests of groups of the society.

In general, some citizens are more concerned than others and may express their concern by participating actively in public debates. In reality though, very few people participate as individual citizens (NordForsk 2009). Most of these citizens are organized in non-governmental organizations, being members of social organizations that reflect their interests or ideological ties.

Labour unions work as stakeholders on behalf of their members. With researchers and well-known research institutes in their membership[2], they are active in the science in society public debate, and also provide funding for new research. They have recently been criticising governments and especially Ministers of Science for putting too much emphasis on applied research and strategic planning of research, and for creating too much management culture at the universities. (Siune 2009)

Religious groups are also important stakeholders in the science in society deliberation processes, especially when it comes to ethical issues or risks. The Catholic Church is exceptionally active in setting the agenda for ethical debates about GMOs, stem cell research and other science-based technologies.

Think tanks, interest groups, citizens' networks and other civil society organizations have become more visible and influential on the public agenda for research. There are a great number of such interest groups, organized in virtual or real networks on both the national and international levels.

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The main issue is whether the various stakeholders can reach agreements on how they see and how they want to see the role of science in society. The changing pattern of coalitions is of great relevance for the future of ERA.

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Media

The role of media as key stakeholders in communicating science is explained in more detail in Chapter 6. While their prime function is still the dissemination of new knowledge in the growing knowledge society, essential for the dissemination of science and research results to society, the media also play a key role in setting the agenda for the science-in-society discourse. Besides transmitting the messages of governments, industries and NGOs, very often the mass media interprets research results and scientific advances, sometimes without a thorough examination of the validity of the interpretation or the credibility of sources.

Museums and Arts

Museums, libraries and other cultural institutions are also stakeholders of science in society in connection with education and communication of science. Even though they play a minor role compared to schools or the media, they still reach large numbers of diverse people in society, and are supported due to the expectation of their professional approach to the popularization of science and their role as agents for successful dissemination to a broader audience, engaging more citizens in science in the process.

3.3 Trends and cutting-edge issues

The context of science in society has been changing as the active stakeholders become more numerous and varied than before. In accordance with the Barcelona Agreement (COM 2002a) the funding of European research activities should be funded by member states (one percent of GDP is

[2] For example, the European Trade Union Institute http://www.etui.org/ and the TURI network http://www.turi-network.eu/ regularly publish research papers.

agreed as the goal for 2010), to be supplemented by private sources amounting to double the state funding. It is noteworthy that while private non-profit funding does play a role in Europe, it is minor compared to that of the business sector.

There are dynamic changes in the types of actors and ongoing fluctuations in their power and in their interests. New networks are formed and new social organisations emerge, with or without the help of rules provided by the state via laws or via public support.

The main issue is whether the various stakeholders can reach agreements on how they see and how they want to see the role of science in society. The changing pattern of coalitions is of great relevance for the future of ERA.

The context for the interplay between science and society has changed considerably as **there is much more open discussion** in the mass media. **Access to scientific information** is much easier than before due to new technology, and while there are great expectations, at the same time there is **some fear within the population** about how science and technological development can influence their life. This apprehension is not shared by all of the population, nor in relation to all fields of science, but it is often an important factor underlying science and society interactions.

In order to involve and deal with stakeholders, more and more new institutions are formed. These institutions (committees, roundtables, meetings, councils, etc.) very often become stakeholders themselves.

Expert committees are often established and become temporary stakeholders, some involved in producing guidelines for researchers' codes of ethics or codes of conduct. **Ethical councils** have become long-standing actors of SiS, functioning as central stakeholders on certain issues.

Special ad hoc commissions[3], play a special role as temporary stakeholders coming up with many recommendations related to capacity building and to research policy. Commissions and/or committees working on strategic research or changes in research institution management are increasing in numbers across Europe, and they all become stakeholders in SiS.

3.4 Challenging futures

The number of stakeholders in science in society has increased dramatically over the past few years. This **growth in the number of stakeholders and the diversity of their interests** in itself constitutes a challenging future. The present map of stakeholders is not complete, and it is impossible to identify them all due to a number of reasons. Stakeholders are numerous and their real motivation to engage with science is often not revealed publicly. The overview of interactions between stakeholders would make it possible to evaluate their role in the interplay between science and society. A broad analysis of changes in power instruments and how stakeholders perceive their own interests and roles should ideally be included in future studies of science in society.

So far, we have focused on stakeholders that act publicly. Nevertheless, there are other interest groups (e.g. shareholders or economic interest groups) that **intentionally avoid publicity**. Some of these groups have considerable economic power. Without them, much research would never be

[3] Like The Danish Globalization Council 2005-06 and later the Swedish Globalization Council (Kallerud et al 2007).

conducted. Analysing the influence of such stakeholders is even more challenging than doing so for actors known from the public debate.

There is also a **growing public mistrust** of stakeholders of various types as stated in *Taking the European Knowledge Society Seriously* (Felt et al 2007). Distrust between citizens and stakeholders, be they European or global, is a threat to a positive interplay between science and society.

The role of civil society organisations and the role of other types of stakeholders have increased in the last two decades. The MASIS expert group claims it is necessary to increase the transparency of stakeholders in order to avoid unnecessary distrust that often poses a great challenge to public engagement activities.

Chapter 4 – Governance and the role of Science in Society

There are a number of reasons why governance of science, and more broadly of science-in-society, has become important. There is a concern that self-regulation of science, however important as an ideal, is not enough in contemporary societies because of the pressures on science and the science system. There is a broadening of policy for science to include more questions than funding, institutional infrastructures and knowledge transfer, e.g. including more social actors. In addition, there is what one might call 'sharpening' of policy for science, where accountability for performance is emphasized. There is also reflexivity, in the sense that appreciation of as well as concerns about the roles and impacts of science in society have become an occasion for governance of science-in-society. The emergence of technology assessment and the more recent emphasis on ethics are examples of reflexivity.

4.1 Contexts of governance

The first action line of the Science in Society work programme highlights core issues of governance of science-in-society. The overall objective is 'to contribute to a better understanding of the governance of science and to support the development of an open governance of scientific research which encompasses societal concerns and involves civil society and its organizations in research policy' (EC 2008c). Increased focus on governance was a key point in the report of the *Gover'Science Seminar 2005* (Stirling 2006). The challenges of the knowledge society add further requirements on governance, as well as a critical look at the present situation (Felt et al. 2007).

The importance of governance of science-in-society is itself part of broader developments. These range from changes in modes of knowledge production and increasing re-contextualisation and intertwining of science and society (cf. Nowotny et al. 2005), to pro-active interactions by social groups (for example, patient associations) and an overall shift toward liberalisation and new public management on the one hand, and democratization on the other hand. In addition, sustainability issues require **reflexive governance** (Voss et al. 2006), and this has also implications for science and its governance.

Relevant trends were outlined in Chapter 2. Here, we briefly note the **European political context.** The European Commission delivered a White Paper on European Governance concerning 'the way in which the Union uses the powers given by its citizens' (CEC 2001, p.3). The aim of that document was to open up the policy-making process to involve more people and organisations in the shaping and delivering of EU policy. It promotes 'greater openness, accountability and responsibility for all those involved'. To this end, the Commission will improve the dialogue with government and nongovernmental actors of third countries when developing policy proposals with an international dimension. (COM 2002b, p.598)

The European Commission's approach can be linked with the increasing interest in deliberative democracy, which emphasises public debate, collective reasoning, and reflection as imperative elements in a legitimate political community. In policies and activities concerned with public participation in science and technology, the normative ideals of **deliberative democracy** have become highly influential (Siune and Mejlgaard 2009). Their role, however, is different in the different political cultures of Europe.

At the same time, **the Lisbon Strategy** (2000) indicated another political context for science, pushing for increased investments and other actions in research and development as vehicles for economic growth. The Barcelona Agreement (COM 2002a) set a target of three percent of GDP (one percent by government and two percent by the private sector) to be spent on R&D. The envisaged role for citizens is now different: to support innovation. The Aho Report (Aho et al. 2006) calls for 'fostering a culture which celebrates innovation', and continues: 'Europe and its citizens should realize 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.'

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Good governance refers to the principles of openness, participation, accountability, effectiveness and coherence. For science, there is also the need to assure the productive functioning of its endeavours, and the maintenance of scientific integrity.

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There is a third important context, linked to the need for science to function properly, on its own terms and in relation to society. One can use the concept of '**good governance'** here. For nation states and for business organisations at least in relation to their shareholders, good governance refers to the principles of openness, participation, accountability, effectiveness and coherence. For science, there is also the need to assure the productive functioning of its endeavours, and the maintenance of scientific integrity. Pressures for democratization, for expert advice and for economic relevance can sometimes threaten scientific integrity. While this has led, in some quarters, to a call for re-establishing the autonomy of science, the real challenge is to create robust forms of scientific integrity which can address these new contexts.

The three contexts offer contrasting messages, and in practice, compromises have to be found and managed. In general, there is not one governance framework, but a mosaic of governance issues, existing governance arrangements and attempts to improve them. This chapter explores the governance of science in the new contexts, moving from the functioning of science to its interfaces and interactions with society. In doing so, we recognise the contrasts and identify cross-cutting issues, but do not attempt to offer solutions.

4.2 Trends and challenges

The distinction between 'policy for science' and 'science for policy', first proposed in the 1960s, is still relevant, but can usefully be rephrased in terms of governance. We present some items below. The important trends, however, are at the interfaces (and grey zones) between science, policy and society. To capture this, we speak of governance of science-in-society.

There are increasing interactions between organisations in the national and international research systems, *ad hoc* as well as more institutionalized, and focusing on coordination and/or cooperation.

One example is the combination of universities now also pursuing a 'third mission' of service to society, social organizations actively interested in scientific knowledge, and industrial companies outsourcing R&D. There is no overall governance framework, but there are government incentives, attempts to improve arrangements (e.g. about divisions of labour and intellectual property rights), and concerns – of various kinds, cf. above, the different political contexts and their messages – about directions and progress that is made.

In later sub-sections, we focus on trends about the anticipation of (co-produced) societal impacts, linked to trends towards upstream public engagement, as well as induced self-regulation as visible in codes of ethics. The recent reference to the notion of 'responsible development' is a further entrance point.

4.2.1 Governance of scientific institutions

We identify a number of different trends. While these may be viewed as assorted items, they actually add up to a *de facto* governance of science, and this should be assessed as to its quality and effects. The German research programme on the new governance of science, defined and supported by the *Bundesministerium für Bildung and Forschung*, can be positioned as an attempt in this direction.

Universities are subjected to different pressures, but are also actively embracing some of them, such as when they refer to their position on one or another of the ranking lists (Shanghai, Times Higher Education) and formulate goals in terms of their ranking on these lists. There are government incentives to stimulate excellence, the German *Excellenz Initiativ* being the most explicit; while at the same time the 'third mission' of universities is emphasized.

This is inextricably linked to the increasing **importance of evaluations** (related to new public management and an overall trend toward an audit society). Evaluations have strong steering effects, because research funding and careers will depend on the evaluation results. Scientists and researchers as well as science managers therefore adapt to evaluation criteria. At the moment, there is an emphasis on criteria internal to science, and in particular on publications in ISI-recognized journals. This is widely recognized as a bias, but one that appears difficult to overcome.

The ISI system favours highly de-contextualised work and has problems with customer-oriented knowledge, with politically relevant knowledge, with 'strategic intelligence', with inter- and trans-disciplinary work, etc. Universities and other organisations in national and international research systems may consider dual-track approaches, where other achievements also count rather than solely the publications in high-impact journals. Interactions with government departments and business companies appear to go well with the pursuit of scientific excellence, but interactions with civil society organisations may need some affirmative action.

In addition to internal democratization of research organizations, starting with universities in the 1970s, when students and administrative personnel became part of academic councils at various levels, there is also external democratization, where social actors become members of boards of universities, and in some countries, particularly the UK, of boards of research funding agencies. We note that these trends have not made much difference to the focus on scientific excellence.

Another trend is the increased dependence of research organizations on **external funding**. A pre-cursor is the introduction of the customer-contractor principle for public research organisations in the UK in the 1970s, where block funding of institutes was replaced by contracts with customers, often the same agencies that had been granting block funding. For universities, research funding by block funding from the relevant government ministry is increasingly replaced by grants and contracts from various sources. The source (funding agencies and programmes including the EU Framework Programmes, the business sector, government ministries and agencies, charitable foundations and some NGOs) is less important than the modality: grants leave the researchers some freedom, while contracts bind them to deliver specified products. While some foundations have a major impact, like the Wellcome Trust in the UK which funds more medical research than the Medical Research Council (it does coordinate with the MRC), the relative impact of private non-profit organizations is still very limited in most European countries.

If one also adds the role of global sponsors, it is clear that there are many funding opportunities for strategic research in all disciplines. It is also clear that research groups and research organizations move on these markets, pursuing their interests. One may hope that the many invisible hands add up to productive *de facto* governance. Since there is no explicit and authoritative governance framework, evaluation of the evolving mosaic, to be taken up by actors, is an important input into improved governance. As we shall see when we discuss 'responsible development', it is not just a free-for-all market struggle, and evaluations may make a difference.

4.2.2 Science and policy making

'Policy makers without access to sound scientific advice, or to dialogue with communities, will be unable to make the best decisions on tough challenges facing the country. [...] As a government we want the public to be confident that when we make policy decisions we take into account the best scientific knowledge available.' (*Vision for Science and Society* 2008)

This sentiment is also visible in US President Obama's call to restore science to its rightful place in policy making (Ch. 2). The tension between whether scientists should be 'on tap' or 'on top' (to quote an aide of US President Nixon, who definitely favoured the 'on tap' approach) remains. The adage of 'speaking truth to power' is too simple, because 'truth' is often equivocal, and power also depends on evidence (Hoppe 1999). Still, scientists can be pro-active, and push the promise of their findings and insights, or occasionally, the warnings.

There is a large literature on issues of scientific expertise and policy making, with Fischer (1990) and, Jasanoff (1990) offering important insights. On the question of governance, an important issue is the translation of always insufficient scientific findings into robust policy advice. There may well be pressure from policy to interpret uncertainties in such a way that favoured policy options are supported. The Bush Administration in the US was apparently shameless in doing this, but such pressures are always there. There are similar pressures on the relations between scientists and companies, e.g. in the pharmaceutical sector; or for that matter, with NGOs pushing worthwhile causes. Some governance measures have been put in place, like the disclosure of interests (in publishing, in assessing manuscripts or proposals). There are also watchdog groups, and sometimes individuals who blow the whistle on misconduct. In the US, the Office of Research Integrity (formerly based at the National Institutes of Health, now at the Department of Health and Human Resources) looks into cases that are submitted to them.

The pro-active role of scientists in offering promises is accepted more easily (even if not always followed up) than when warnings are voiced which disturb existing arrangements (Harremoës et al. 2001). One problem is that warnings are always speculative, building on indications and theoretical modelling, and thus vulnerable to accusations of lacking empirical support. They may set in motion programmes to gather relevant empirical data, as happened with the warning about damage to the ozone layer in the 1970s that has led to major research and advice activities about climate change and greenhouse gases (and thus new opportunities for researchers).

A further step has been the acceptance of the **precautionary principle** by the European Commission (CEC 2000), which has been construed as a contrast with science-based regulation favoured by the US. The precautionary principle does not do away with scientific inputs. It accepts that there are uncertainties in the relevant science, and is prepared to act before all uncertainties are resolved. The pressure on science to resolve uncertainties remains, but the governance context is different.

4.2.3 'Responsible development' and 'ethicisation'

The idea of 'responsible development' of new scientific-technological developments has gathered some purchase, especially for nanotechnology. The quote below refers to the US National Nanotechnology Initiative:

> *'Responsible development of nanotechnology can be characterized as the balancing of efforts to maximize the technology's positive contributions and minimize its negative consequences. Thus, responsible development involves an examination both of applications and of potential implications. It implies a commitment to develop and use technology to help meet the most pressing human and societal needs, while making every reasonable effort to anticipate and mitigate adverse implications or unintended consequences.'* (National Research Council 2006, p. 73)

Earlier experiences with new technologies like genetic engineering, and the problems with their societal acceptance, were an incentive to try and 'get things right from the very beginning' (Roco and Bainbridge 2001). Apart from the symbolic politics involved, there are two major issues. One issue is that impacts are co-produced so that there can be no simple attribution of responsibility. (Schomberg 2007). The other issue is how governance issues are rephrased as ethical issues.

The understanding of processes of research and development (R&D) as well as of innovation processes has been changing. The linear model – framing a linear sequence of steps from research to innovation to new products and processes – does not represent the complexity of real-world processes. Interlinked and systemic models of R&D, of innovation and of innovation systems have been developed, which also offer opportunities for influencing R&D and innovation processes to societal actors and groups. In addition, the recognition of co-production has made knowledge of the social contexts in which innovations will function – such as economic circumstances, social perception of problems, political and cultural frameworks and ethical compatibility – important. In such a world, 'responsible development' is not a symbolic reference, but can be made operational.

One indicator is how ethical reflection and technology assessment, until recently undertaken at a distance from R&D and innovation and often regarded as attempts at external 'control' or even 'harassment' are taken up as part of R&D programmes, sometimes under the heading of ELSI or ELSA (Ethical, Legal and Social Implications, or Aspects). Even more recently, science institutions, including research funding agencies, have started taking a pro-active role.[4] Thus, the governance of science and of R&D processes is changing and this creates further openings for involving new actors and new types of reflection.

European Commission documents, particularly those on nanotechnology, often refer to **responsible innovation**. Recently, a further step was taken by preparing and publishing a code of conduct for nanoscience and nanotechnology (N&N) research (EC 2008a). The restriction of the code to 'research' was necessary, because of the limited remit of the European Commission in this respect, but the code is broader, and refers also to public understanding and the importance of precaution. There are explicit links to governance: the guidelines '*are meant to give guidance on how to achieve good governance',* and when this is further specified, there is also this interesting item: '*Good governance of N&N research should take into account the need and desire of all stakeholders to be aware of the specific challenges and opportunities raised by N&N. A general culture of responsibility should be created in view of challenges and opportunities that may be raised in the future and that we cannot at present foresee.'* (EC 2008a) A **general culture of responsibility** cannot be created by the European Commission alone, of course, but they clearly see themselves as pushing for it.

This move has been captured by notions of **'ethicisation'** of technoscience, where governance of technoscience issues are increasingly framed through a language of ethics and morality (see Strassnig 2008, Gottweis et al. 2008). It is too early to see how this move will work out in practice and especially which actors will actually change their ways and how. Basically, the move can be applauded, and not only because responsibility is always morally good. As we noted above, 'responsible development' is also a way to improve the co-production of innovations in context.

Actually, an exclusive emphasis on ethical aspects is problematic. A reduction occurs when issues tend to be translated as ethical issues, with ethics becoming a soft legal tool. Gottweiss phrased it for the life sciences where this trend is particularly visible: '*A common feature of the politics of life areas … concerns the salience of a language of ethics and morality. Issues turned out to be strongly framed in normative terms such as "moral obligation" or "responsibility", the qualification of certain courses of action as being "ethically permissible" or not, "moral" or "immoral".'* (Gottweiss 2008, p. 281) In that same movement, ethical expertise becomes a dominant input, visible in the deference to ethics committees (Felt et al. 2009). Ethical deliberation then is not an exercise opening up diverse imaginations about issues at stake, but becomes a boundary-drawing move.

The governance aspect of ethics is particularly visible in codes of conduct attempting to contain undesirable or unacceptable behaviour. In response to misbehaviour and negative effects, codes of conduct are proposed (and accepted) for firms, for politicians, for banks (made stricter after the financial crisis). Similarly, codes of conduct for scientists are related to the occurrence of '**research misconduct'** (as the US Office for Research Integrity phrases it, now adding stimulation of

[4] Examples are the Dutch funding agency NWO's program on *Maatschappelijk Verantwoord Innoveren* (www.nwo.nl/mvi), and the Norwegian Research Council's programme on Ethical, Legal and Social Aspects of New Technologies (www.forskningsradet.no).

responsible research conduct)[5] and to concerns about scientific integrity. Codes of conduct can be formulated voluntarily, and are then often quite general. The UK Department of Innovation, Universities and Skills presents a '*Universal Ethical Code for Scientists'* on its website under the heading 'Rigour, Respect and Responsibility'[6]. The recent European Union code for nanoscience and nanotechnology research goes further than scientific integrity and addresses issues of science-in-society.

4.2.4 Robust forms of scientific integrity in context

Integrity of science is a concern of scientists themselves, and they feel they have to defend it against inroads of various kinds. The reference to the need for autonomy of science, while still heard, is not a sufficient response, however, and is definitely not a good argument to reject external attempts to formulate codes of conduct or codes of ethics. The **combination of self-regulation and external regulation of science** should be the focus. A code of ethics or declaration of commitment is one way to create such a combination, and we discuss the case of bio-security to show how the code of conduct evolved, and how it can be seen as a dynamic form of governance. Of course, codes of ethics are not all that is necessary. One could accept that 'A code of ethics and standards should emerge for biological engineering as it has done for other engineering disciplines' (Church 2005, p. 423), but it should not substitute for ethical reflection nor exclude shaping of democratic opinion.

One of the challenges is to weigh the potential benefits of research against risks of its abuse. In medical practice, doctors are obliged to make choices (frequently charged with moral dimensions) concerning treatment of their patients. Their decisions – often difficult and controversial – are guided by various ethical codes (e.g. Helsinki Declaration). Scientific researchers are not in a position to make such moral choices, e.g. about what constitutes an acceptable risk to society, but should still observe rules and standards derived from collective judgment (e.g. professional organizations, public bodies, etc.)

The engineering disciplines are close to real-world impacts, and some external regulation can be justified in those terms. In new and promising fields like genomics, nanotechnology and synthetic biology, the distance from the real world is still large, but promises are plentiful. In a sense, these fields are like engineering disciplines, even if it is engineering in the protected space of the laboratory. Their strong design orientation implies that anticipation of impacts, and some form of accountability, is necessary. While disciplines like chemistry have long had such an orientation, and have had to come to terms with impacts on society and public concerns, the combined internal-external governance challenge was first taken up explicitly, and in an anticipatory manner, in the early years of recombinant DNA research. The 1975 Asilomar conference is the landmark event in this respect (see Krimsky 1982) which continues to be cited as a model. At the second global conference on synthetic biology in 2006, an Asilomar-type declaration envisaging self-obligations was passed, although only referring to possible military uses of synthetic biology. This then prompted 35 nongovernmental organizations (including ETC Group, Greenpeace and Third World Network) to write a joint letter indicating the many other science-in-society issues that should be considered.

[5] ORI is now part of the US Department of Health and Human Services, see http://ori.dhhs.gov/
[6] www.dius.gov.uk/policy/science-society.html

A key issue is that rapid advances in scientific fields offer not only benefits, but also pose risks that the knowledge accumulated will be used for malevolent purposes. The possibility of **'dual use'** (for civilian and for military purposes) has been recognized for some time, but it is a broader phenomenon, and the dilemmas involved are relevant for the governance of many scientific fields.

Take the case of biomedical research with its potential to develop biological weapons or any other form of bioterrorism. In September 2002, the UN General Assembly and Security Council passed a resolution calling for the reinforcement of ethical norms and the preparation of relevant codes of conduct for scientists involved in technologies that could produce weapons of mass destruction. In 2004, the Interacademy Panel (IAP) adopted a Biosecurity Initiative and one year later issued the Statement of Biosecurity. In response to this, the Royal Netherlands Academy of Arts and Sciences (KNAW, the IAP's 'lead academy' for activities relating to biosecurity) conducted a survey of measures already taken by central governments, fellow academies and research institutions worldwide. A further survey was made of current legislation and existing codes of conduct with relevance to biosecurity. A draft Code of Conduct for Biosecurity was adopted by the board of the KNAW in 2007 (Vloten-Doting 2008).[7]

One of the controversial issues remaining is whether it is ethical to restrict scientific publishing if potential dual use is involved. In 2003, a group of editors and publishers of leading scientific journals (*Science, Nature, PNAS US)* drafted and then published a *Statement on Scientific Publication and Security* (Atlas et al. 2003) which stated: '*if the potential harm of publications outweighs the potential societal benefits, a manuscript may be rejected'.* The intention is clear, but the problem is still unresolved, as it is unclear who should be responsible for making the decision about whether indeed such potential exists.

Both internal and external initiatives can be seen, and it is clear that after a first step (a draft code) further problems emerge (e.g. about publication) which have to be addressed somehow. Clearly, there is no once-and-for-all governance arrangement. The challenge is to keep such arrangements dynamic. This is actually a general point: sciences, technologies and their interplay with society develop all the time, and while governance arrangements should address immediate problems, they should also be sufficiently flexible to adapt to new problems.

4.2.5 Competencies to anticipate and arrangements for feedback

Responsible development and attempts to address possible future dual use require not only commitments and sometimes codes, but also competencies to anticipate, and arrangements to feed back such anticipations into ongoing developments. There is quantitatively oriented forecasting and qualitatively oriented foresight, there are cost-benefit and risk-benefit analyses. These are important inputs, but for governance issues broader approaches are necessary. In the same vein, the *Taking Knowledge Society Seriously* Report (Felt et al. 2007) argued that what is needed is a move from risk governance to innovation governance, meaning to move away from a more narrowly framed imagination of risk and take the innovation process as a whole as the topic of reflection and consideration.

[7] The Code of Conduct is available, along with other existing codes, on the website: www.biosecuritycodes.org

In this respect, two overlapping developments must be noted: the renaissance of **technology assessment (TA)** and its possible further evolution, and the role of visions of the future and their assessment.

There is increasing interest in technology assessment (TA) in the growing Asian economies, and renewed interest in the United States, and high-tech companies faced with uncertain public reactions are willing to participate in TA activities. The basic idea of **Constructive TA** (Rip et al. 1995), to use TA thinking for contributing to technology development, is finding a new audience. Especially in Europe, TA has developed participatory and agenda-building approaches, like consensus conferences, and is thus involved in the development of technological citizenship in a deliberative democracy. Consideration of, and debate on, technology-based futures and visions are then an important component. On the other hand, TA thinking and ethical reflection is increasingly integrated into R&D processes from the very beginning. The growing field of ethical parallel research (e.g. in many EU FP6 and FP7 projects) is an indicator of this development.

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Even if the promise is mostly hype, one might still go along, just as players on the stock market can invest in rising stocks. Individuals can choose to embrace the hype or go for modest strategies. For a society, the stakes are larger.

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In current TA, it is not just a question of the consequences of individual technologies, products or plants, but of complex and conflictual situations between newly emerging science and technology, enabling technologies, innovation potentials, patterns of production and consumption, lifestyle and culture, and political and strategic decisions. Specific TA methodologies remain important, but they now contribute to addressing the larger and more complex governance issues. Their role is not just to anticipate but to open up opportunities to consider science and technology in society from different angles and to allow for feedback at different levels. One further element is to engage publics, and engage them playfully, as in the technology 'festivals' organized by TA institutes in the Netherlands (Rathenau Institute) and Flanders (Institute Society and Technology). What these developments in TA herald, and support through their concrete activities, is **distributed governance** of science and technology in society, ranging from companies interacting with societal actors, e.g. in TA workshops, to public dialogues on new technologies that feed back into decision making.

In addition to professionalized anticipation as in TA, there are expectations and promises put forward by technology promoters, and larger visions about brave new worlds, utopian or dystopian. Such promises and visions may be diffuse and speculative, but they do shape actions and interactions. Mid-term and long-term visions are of increasing importance in the scientific, political and public debates on future technologies in new fields like stem cell research, brain science, nanotechnology or concerning the enhancement of human performance expressed in the NSF report on *Converging Technologies* (Roco and Bainbridge 2002). They often enter public and political debate successfully, and they influence public funding as well as science and technology policy, and will have a great impact on technological pathways into the future. For this reason, Grin and Grunwald (2000) called for vision assessment.

Of course, visions are difficult to assess because they are broad and diffuse, and because they mobilize for or against a technology rather than offer a systematic argument. But one can assess the role visions play in debates and decision making. For example, the vision of nanotechnology as leading to a third industrial revolution may be completely unfounded, but reference to this vision justifies governments setting up nanotechnology R&D programmes. Even when government actors do not believe in this vision, they are still forced to spend money on nanotechnology because other countries do, so they will invoke a third industrial revolution, and thus reinforce its status as a vision.

This is just one example of the role visions can play, but it illustrates some of the governance issues for newly emerging sciences and technologies. Their promise is necessarily articulated in visions, but the choice to go with the promise, or to refuse to jump on the bandwagon, cannot be made in terms of the plausibility of the promise alone (Grunwald 2007a). Even if the promise is mostly hype, one might still go along, just as traders on the stock market can invest in rising stocks. Individuals (scientists deciding on new research, government officials deciding on funding programmes) can choose to embrace the hype or go for modest strategies. For a society, the stakes are larger. And there is the broader question of why we should run at all after these techno-scientific promises. The common response is fear of falling behind in the global economic competition, but this is only convincing if there are real, long-term societal advantages involved. Clearly, governance of science-in-society requires a critical examination of the contexts of governance (as outlined in Ch. 4.1).

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In general we should think of science as a public space composed of complex and evolving networks of overlapping and often competing significances and social actors.

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4.2.6 Public engagement and the move upstream

An increasingly knowledgeable public is expected to become a critical 'passage point' for any science policy, and policy makers are becoming increasingly attentive. The main response is to add public engagement, in one form or another, to the range of consultation and advice. For new technologies like genetic engineering, genomics and nanotechnology, public debates may be essential to the development and promotion of 'knowledge society' policies, ensuring the viability of policy options. Earlier examples for genetically modified organisms and food were not completely convincing, while public dialogues about nanotechnology are now being prepared in a few countries. A key challenge is how the outcomes from such dialogues are taken into account when specific policy initiatives are articulated and implemented.

Independent of a policy focus, **deliberative processes** about science-in-society are considered to be important generally because of ideals of deliberative democracy (cf. Ch. 4.1) and because such processes can identify issues or concerns that deserve to be taken into account. In addition, over the last decades, a public discourse about science-in-society has emerged, which used to be carried by civil society organizations and self-appointed spokespersons, but has become broader because of wider access to relevant knowledge sources, with the internet playing a key role (cf. Ch. 6), and because of learning, i.e. members of the public becoming more knowledgeable and more willing to engage. Thus, questions of public relevance can be debated by a broader audience and a public of citizens who perceive that there are questions at stake which concern their lives, their sense of morality and citizenship. This can take the form of controversies, as in the case of bio-political and ethical dilemmas, which might actually be welcomed when they serve to articulate further public discourse.

There is another trend of **increasing public involvement in science**, up to involvement (like the wish to have a say) in research processes themselves. This might be seen as external interference with science, because it goes further than the accepted need for science and scientists to make decisions and results clear, and communicate them with broader audiences. While there may well be cases of undue interference (and science would be justified to protest against them), in general we should think of science, as we showed in Chapters 2 and 3, as a public space composed of complex and evolving networks of overlapping and often competing significances and social actors. Rather than attempting to exclude them as external, the challenge is how to incorporate productively the variety of actors and the variety of expectations.

Public engagement has become an umbrella term covering public consultation, public discourse and public involvement. In spite of the specific difficulties and challenges involved, it tends to be seen as the right thing to do. As the *Public Engagement in Science* (2008) report concluded, 'survey results show that there is broad agreement on the need for deepening public engagement in science, [but] considerable differences remain regarding what it means in practice'.

There is pressure to have more public engagement with science, definitely from the side of policy makers, and to have it at an early stage. The UK in particular has embraced so-called upstream public engagement (the metaphor 'upstream' referring to the time and place where new developments are still uncertain and immature – and flexible) (Wilsdon and Willis 2004). Citizens themselves may be reluctant, not because they are not interested in participating in public discourse, but they do not feel sufficiently representative to have their views taken up in decision making, in the consultation mode (Felt and Fochler 2008).

With the many upstream and midstream engagement exercises, the expectation of more to come, and thus a certain institutionalization of public engagement (in its various forms), a new kind of actor has emerged, the engagement mediator, consultant and entrepreneur. This will professionalize public engagement, so that it will be more immediately productive, but it may also undermine the original intent of deliberative democracy.

The outcomes of the deliberative processes in public engagement exercises, especially about newly emerging technologies where the engagement is upstream by definition, have turned out to be bland and predictable, as is to be expected when there is little experience and insight on the part of the members of publics who participate. As Strassnig (2008, pp. 108-109) pointedly formulated it : 'How far can a debate move upstream and not end up as idle talk?' This is not to say that (upstream) public engagement has nothing to offer, but that there is a challenge of **developing competencies** for science and technology appraisal. As Rip (2008) has argued, science and technology appraisal competency is more than and different from so-called science and technology literacy. The key requirement is understanding the political/power and ethical, legal, soci(et)al aspects, although some knowledge about scientific concepts and processes may also be necessary.

Public engagement is full of tensions, and after the recent wave of enthusiasm, it is time to consider renewal, at least in its relation with governance of science-in-society. While it will remain important for dynamic governance, it is only one element in it. There are two directions to go. One is to be more specific about the nature and goals of public engagement exercises. Our distinction between public consultation, public discourse and public involvement is one entrance point. The other direction relates to knowledge societies and ideas like technological citizenship, independent of particular engagement exercises. Commissioner Potoznik's claim that Europe should aim for engaged citizens[8], may be too limited, but it is definitely an entrance point.

[8] The engaged citizen is, according to Commissioner Potoznik, a main goal for Europe (opening message from the commissioner to conference about responsibility and dialogue held in Paris, November 2008).

4.3 Challenging futures and cutting-edge issues

The focus of this chapter has been governance of science and governance of science-in-society. There are developments in science and society which are relevant to the question of governance because they play a role in all the issues. A key cross-cutting development in this respect is the **changing modes of knowledge creation**, as discussed in Chapter 2, where more actors and more locations are involved, and 'societal robustness' of knowledge is important (Nowotny et al. 2001). The other key cross-cutting development is the move to **enhance democracy** by including more, and more bottom-up, deliberative processes. These two developments, by themselves and together, generate governance challenges.

A key challenge is created by the **contrasting signals and incentives** emanating from the different contexts of governance, and then taken up in specific governance arrangements. There is the pressure for excellence, somewhat isolated from society, and the pressure for relevance, directly and indirectly (cf. strategic research, Ch.2). While excellence and relevance can go together in the concrete work of research groups and institutes, the governance arrangements are separate, and this creates unnecessary burdens on scientists and scientific institutions. It also creates difficulties for responsible development and public engagement, because scientists may take recourse to the need to go for excellence, i.e. prioritize basic research and not be concerned with eventual effects.

A further contrast is between strict **accountability requirements** (as part of the move towards an audit society) and the need to be transparent towards society. The indicators used in evaluations and other audits are not very informative about what is actually being done and how this is embedded in society. Information should be produced and disseminated in a citizen-oriented way, otherwise there is no transparency, and therefore a limited basis for public engagement.

The importance of governance of science-in-society is widely recognized, and 'responsible development' and 'public engagement' are pushed, at least by policy makers. Each of them separately and both together might develop into a great future. In that sense, the challenges are being taken up. But it is not sufficiently clear what their thrust is and should be, and there are a number of tensions visible in their present forms. Examples are the delegation of responsibility to ethicists and other professionals, and the difficulties of public engagement to produce science and technology appraisal. Some learning is occurring. This also implies that present governance arrangements may have to change.

At the same time, ethics has become a political instrument to normalize innovation and to facilitate change. It has been instantiated and captured through numerous ethics committees that have consequently become privileged places to speak in the name of society. Yet, the new type of ethical expertise being created means that in most cases **ethical deliberation** is by no means a broader participatory exercise, but rather should be understood as a boundary drawing exercise. (Felt et al. 2009) The challenge is thus to think about how to develop a broader way of reflecting on these issues and to the initial commitment to engage with stakeholders in a less formalised way, using a wider variety of tools ensuring true deliberation.

The key challenge for all futures is to **allow for dynamic governance.** This cannot be done by using legal instruments or by evolving normative guidelines. It requires an open-ended attitude towards governance, a willingness not to press for complete closure.

Chapter 5 – Strengthening Potential

Human capabilities are considered as an individual as well as a public matter in the European Union. Human resources – individuals, communities and their environment – have become a core factor for sustainable development, cultural transformation and socio-economic change, also in the scientific domain. Lifelong learning, formation and training of qualified human resources in the knowledge economy and information society are at the top of the EU agenda. In particular, there are attempts to make science and scientific careers more attractive for younger generations and more inclusive. While EU policies set targets for more scientists, a basic question still remains open and unanswered: Why and to what ends are scientists needed for future societies and for the socio-economic development of the European Union? In particular, why should science policies be addressed to target groups like women, minorities and young people? This chapter puts this issue into a larger context first by broadening the concept of human capacities, and second, by highlighting the importance of society's perception of science that sets the framework for strengthening potentials in the science in society context.

5.1. Theoretical framework: Development of human capabilities and social well-being

Potentials are related to notions of capacity and capability, conceived of as the ability that a human being has to act, to create new things and to transform the environment (s)he inhabits. *Capacity* is generally defined as 'the ability to learn and retain information; to do something', while *capability* is meant as 'the quality or state of being capable'. This approach was introduced into public and scholarly debates by the Nobel Prize-winning economist Amartya Sen, who evaluated the development of human well-being in various socio-economic and cultural contexts in terms of the functioning of human capabilities. According to Sen, a fair welfare state must allow all citizens to use their capabilities as part of their positive freedoms. Therefore '*capability, as a kind of freedom, refers to the extent to which the person is able to choose particular combinations of functioning (…), no matter what the person actually decides to choose.'* (Sen 2004, p.334)

In light of this statement, is the **capability approach** applicable to the scientific domain where the waste of talents represents a form of human deprivation? Millions of people, even within the European Union, do not have equal access to education, so that they are not in a situation to use their capabilities, and consequently be empowered by them, due to socio-economic, political and psychological constraints. *Vice versa*, science has to enhance individuals' potentials as a matter of empowerment, social justice, and fair distribution of collective resources and the improvement of societal well-being. Therefore, science must not be conceived purely in economic terms, because by contributing to the development of human talents, it is related to human rights and citizenship. The normative perspective offered by the idea of the development of human potentials permits us to reframe the discourse on the crisis of traditional forms of science and the question about the marginalisation of human groups by employing a ‘transformative’ viewpoint.

Because this issue is crucial for the future of the EU, within its mandate (see Ch.1) the MASIS expert group intends to avoid oversimplifications that sometimes seem to reduce science to a matter of numbers. For instance, the *Gago Report* (2004) focuses on the analysis of factors that prevent scientific careers in order to push innovation and increase human resources for S&T in Europe. The report argues that demand for scientists should generally be stimulated despite the variety of the labour market sectors and the multifaceted S&T areas. Following the line of the *Lisbon Strategy*, an additional 500,000 researchers thus seem to be needed by 2010.

It is the perception of the MASIS expert group that quantitative and economic arguments do not really capture the core of the problem. Therefore, the MASIS expert group suggests an approach that focuses on the **potentials argument**, which implies references to the normative ideals of empowerment, social justice, equal opportunities, anti-discrimination struggles, and freedom of expression, creativity and imagination. Indeed, these concepts are able to indicate the reasons for the persisting deficit in science as well as possibilities for its transformation. Namely, limits in science are not necessarily determined by the lack of legal or economic provisions but by persisting discriminatory cultural dimensions in everyday life. Any good social policy that is aimed at strengthening the potentials of any individual has to be focused on the reasons for persisting forms of discrimination in all spheres of society. As stated by Article 21 of the *Charter of Fundamental Rights of the European Union* (2000)**: ‘***Any discrimination based on any ground such as sex, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexual orientation shall be prohibited.’*

To understand science as a cultural activity and to investigate its impact on society, it is essential to consider ‘**inequalities studies’** (referring to gender, queers, ethnic minorities, etc.) in this regard. Science is based on a paradox: on the one hand it aims to empower people through education, discoveries, researches and professions, while on the other it enables social bias and reproduces power relations.

If we assume the normative perspective of potentials and capabilities, the idea of science as narrowly restricted into disciplines, territories and nations changes radically. Science, understood as the knowledge dominion that consolidates political power, has traditionally contributed to the construction of national and political identities, such as nationalism, colonialism, totalitarianism and contemporary ideologies, within the borders of empires or nation states (Nandy 1990). Lately, the development of measures for the reinforcement of the technological and intellectual dimension in a cross-border perspective has contributed to the valorisation of the interaction between cultural and scientific diversities in the constitution of a social Europe. The cooperation among scientists from different disciplines and cultures has become urgent also because of the worldwide nature of common problems (like global warming, scarcity of natural resources, etc.) which indicates the necessity of global governance (Ozolina 2009). This also makes sector-specific approaches to science impossible, assuming that the common interest consists in reaching a general well-being.

On the basis of these considerations, the question ‘Why do we need more scientists?’ could be reframed and radicalised as follows: ‘Why would we need more scientists?’, anyway ‘What is meant by *scientist*?’, and ‘Why do young people find science less attractive?’ The MASIS expert group argues that these questions can be answered only if the issue of the strengthening of potentials and capacities is addressed from a much broader and more critical perspective.

5.2 Structural and cultural transformations: The changing perception of science

The feared decline of interest by younger generations towards long-term, rewarding scientific careers has to be investigated, considering those structural and cultural aspects that have contributed to changing the previous representation of science as a matter of social prestige and style of life.

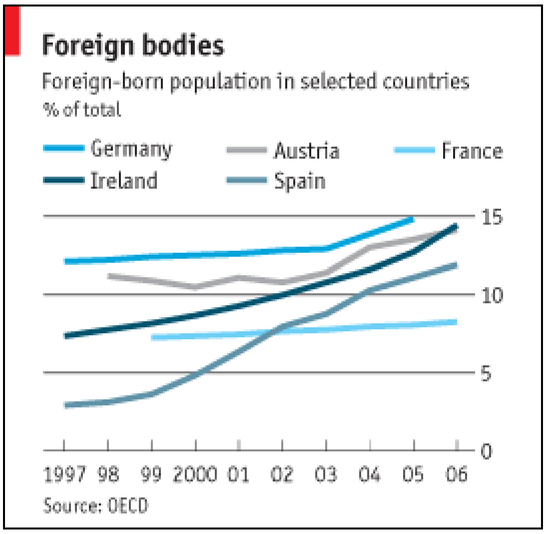
5.2.1 Science careers

The declining birth rate and the ageing of the EU population (although this general trend differs in magnitude across the EU countries) have led to a gradually diminishing labour force in the old member states (Giannakouris 2008). Despite emerging challenges for science and research in coping with this tendency and the inter-generational exchange, the MASIS expert group is interested in investigating the possible effects of this trend on scientific careers. There are actually increasing numbers of students enrolling in both public and private universities, but at the same time there are indications that higher education students are not particularly attracted by a scientific career (Global Science Forum 2008). Is this tendency only related to economic matters? Or is it connected to cultural imaginaries and social transformations, where science is considered to be too difficult and time consuming compared to non-academic professions? The latter seem to be better paid, have a faster career trajectory and a different inter-generational interaction (where age does not necessarily determine the hierarchical position). In this case, the idea of professional success is based on a ‘quantitative’ model of resources: promotion and social recognition are related to economic results, while the career advancement in science and academia is traditionally measured in terms of output (articles published) over many years and the co-optation of the peer community in selection processes (as discussed in Ch.4.2.1).

5.2.2 Global mobility

The global mobility of human resources is a further epochal factor that has changed the traditional environment of science and modalities of production. Many young people, especially with a higher education background, are cosmopolitan to an increasing degree. Beginning at school, they live in a 'global village', although opportunities seem to be mostly restricted to industrialised countries. Therefore, many 'high potentials' search for better careers and chances in countries other than their country of origin, depending on the offers in the job market. This is also the case in the European Union, where science policies and job placements differ widely across member states. For example, there are huge differences in terms of structures and remuneration (Eurostat 2009; Ward et al. 2009) between western and eastern EU states (Bulgarian, Romanian, Slovakian and Polish researchers earn one sixth of Austrian or Dutch researchers’ income, CARSA 2007). The gender wage gap averaged 15.9 percent across the EU27 (Eurofound European Industrial Relations Observatory 2007).

This trend challenges traditional processes of recruiting young people to science which previously took place within domestic borders. The EU has already responded to this situation by enhancing and creating policies addressed both to the 'brain drain' and the mobility of researchers (such as Erasmus and Marie Curie programmes). However, mobility of researchers is not always a free choice, but may be induced because of a lack of jobs in the native country. However, this phenomenon has an innovative potential: science becomes inter-cultural, implying a change in the impact of research over a broader society.



Global human mobility increases the number of young people migrating to the EU. The foreign-born population ratio is rapidly increasing, accounting for most or all of the population growth of certain EU member countries. (OECD 2009)

However, migration is not always due to economic reasons. If the need for mobility has always been part of the scientific endeavour due to the importance of exchanging ideas and experiences, in many cases migration is not a matter of choice. This is the case for asylum seekers and refugees forced to leave their countries due to their opposition to certain political regimes or because they are members of cultural minorities (Gibney and Hansen 2005). In many cases, these refugees or asylum seekers are university students or members of the intellectual elite. Educational and university measures should also be developed for these groups in order to facilitate their introduction to new societies.

5.2.3 Industrialised science

Globalisation has induced the transformation of industrial labour-based societies and consequently the notion and practice of science. Namely, science was previously considered an activity of teaching, learning and researching restricted to academia and laboratories, and an activity performed in delimited spaces. In the new economic and geo-political scenario, science has been 're-contextualised' (cf. Ch. 2). Namely, the possible impact of science, research, innovation and development over society has been summarised under the label **'knowledge society'.** Within this frame, the 'knowledge economy' discourse is constructed upon a narrative of science and development, which takes increasing global competition for granted.

The **industrialisation of science** describes this transition to an organized production of 'mass products' via the specialisation of tasks, rationalisation and normalisation. This includes mass education, e-learning efforts and eventually the transformation of how research is done. (Kleinman and Vallas 2001)

This approach has considerable effects on the intellectual, educational and scientific environment because of the growing inter-dependency between economy, politics and science. New universities, technical institutions, and spin-offs have been established, but they are mainly dependent on external resources. The consistency of private capital for the establishment and functioning of universities has induced a changing paradigm in the evaluation process: while success in academia was previously determined by outputs recognised by a scientific community, now achievement is calculated on the basis of technological transfer and private investment that permits the improvement of laboratories and the employment of young researchers with short-term contracts. Although providing 'fresh resources', the new way of managing science in the name of international economic competitiveness is nonetheless disruptive in many aspects: enforced mobility, short-term contracts, linear careers, dense time regimes, 'projectification' of knowledge production and an exclusive focus on strategic research priorities with a decreasing interest in basic research. Under these precarious work conditions, young researchers feel it is difficult to decide whether or not to stay in this kind of 'production' system. This tendency to a form of 'industrialised science and research' has different meanings and consequences. On the one hand, it implies an increasing dependency of science on the private sector because of the scarcity of state resources and financing. On the other hand, it involves the loss of internal dynamism and creativity, so that a substantial part of the work becomes a 'boring' routine determined by 'external' providers. *Mutatis mutandis,* it seems that a Tayloristic organization of work - a managerial and serial system for improving labour productivity - is coming back (see nanotechnologies): science workers become engaged in specialised but serialised activities which limit their talents and productive interactions with colleagues. The risk is that this narrative could obscure the image of research as a practice aimed at innovative goals based on the autonomy and creativity of the researcher, so that science becomes no longer exciting and university education no longer attractive.

The **audit-society logic,** a 'quantitative' approach (cf. Ch. 4.2.1) where only countable things count (e.g. ISI journal articles, citations, third-party funding, etc.) creates an environment which often ignores the importance of fair and respectful interactions among the participants and makes science for highly qualified young people less attractive. In this case, a discrepancy can be noted between the images of science promoted by policies at both national and EU levels and the social imaginaries and expectations that young people have about an interesting, decent and stimulating working environment. That can explain why, although initially showing interest, young scientists may later decide to leave this environment in search of more stimulating and less frustrating jobs.

5.3 Inclusiveness, equal treatment and equal chance

As argued above, personal growth and the development of science are not necessarily dependent solely on economic factors but also on the quality of interpersonal relations, on a respectful cultural environment and on democratic spaces that contribute to the development of human capabilities and potentials. Therefore, the development of science and increasing the number of scientists depend also on the struggle against any form of discrimination, in order to guarantee equal opportunities for all citizens and measures of inclusion also in the scientific domain. In the next section we consider the key issues of women, youth and minorities in science.

5.3.1 Women in science: towards a new quality of science

Although EU member states have different traditions of gender relations, all national constitutions affirm the equality of women and men as a fundamental principle. Since the 1970s a set of directives on equal opportunities has become compulsory for all EU member states, so that every national parliament must ratify them. Indeed, the acceptance of equal opportunities legislation has become a *conditio sine qua non* of the *Aquis*, the adoption of which is a pre-condition for EU accession of interested countries. Therefore, at present there is no need for the promulgation of new laws, but there is definitely an urgent need to implement and monitor existing provisions. The mainstream approach (like in the case of gender) cannot really work if legislation is not accompanied by practices addressed to the development of potentials, the empowerment of citizens, the support of fairness and the struggle against discrimination.

The European Commission has acknowledged the issue of women in science since 1999 when it became the core of *ad hoc* policies. In 2001, the European Commission established the 'Women in Science' unit, now named 'Scientific Culture and Gender', with the mission to put gender equality in all policies. Later, in 2007, a *European Institute for Gender Equality* was established. Over the years a number of reports have been devoted to the analysis of the situation of women scientists. For instance, the *Etan* (EC 2000) and the *Enwise* (EC 2004) reports have shown similarities in western and eastern Europe, where women scientists have subordinate roles and badly paid jobs in the scientific domain. Certain jobs e.g. care work (of students, equipment, etc.), and articulation work (i.e. work in interdisciplinary contexts which consist in transferring knowledge and know-how) are highly gendered (Felt 2009). Since the 1990s, the gender dimension became central for research and science policies in the EU. For instance, in the FP6 the gender question was conceived in quantitative terms (more women scientists) as well as in qualitative terms (the recognition of gender as a research topic to be explored by experts in this field). The programmes contributed to the launch of gender networks, the promotion of innovative questions, the introduction of debates on the ideology of a narrow definition of excellence (based on male viewpoints in the evaluation of science), and increased public awareness about gender in expert communities (EC 2009b). Policy makers and civil society contributed to the improvement of competences and communalities among experts in gender research, having different cultural and disciplinary backgrounds. However, a specific focus on gender was removed from FP7 so that it no longer constitutes an obligatory assessment criterion, although the gender balance in EC projects is still a requirement. This demonstrates that the idea of equal opportunities as primarily referring to women has undergone a transformation to include a broader set of target groups (cultural minorities, Roma, etc). EU policies on science and education have had a positive impact on the strengthening of personal potentials and the development of inter-cultural practices. This is due to the promotion of projects and networks, although an under-representation of women in science is still visible (as stressed by the *She figure*s (EC 2006) and by the *Annual Reports* of the Helsinki Group).

The **gender and inclusiveness discourse** has thus moved from a formal approach to equal opportunities, to the analysis of the roots of marginalisation and to the systematic 'forgetting' of women's contributions to science, investigating the effects of a 'gender blind' science and the meaning that this segregation has on the production and understanding of knowledge. This analysis and feminist epistemologies on 'standpoint' theory (Harding 2008) have revolutionised traditional views of science by questioning the value system embedded in the scientific enterprise. Indeed, the gender issue is not only a matter of quantity and the necessity to balance the number of men and women who gain access to science, participate in knowledge production and occupy senior positions. A gender perspective in science implies a critical viewpoint about existing epistemologies (Calloni 2006), the proposals for innovative cultural dimensions and the enlarging of intellectual fields that can broaden the functioning of capabilities in knowledge societies. Gender is not purely a matter of 'sameness' between men and women but a criticism against a whole system of values and limited views governing and ordering science and/in society.

Indeed, the **quantitative presence** of women at universities is no longer a problem: in many cases women are the majority and they finish their studies on time with the best scores. Yet, segregation still remains in choosing a course of study, in attending a PhD programme (Meri 2007) and in access to senior positions. In 2007, a Report of the European Commission on the Equality between Women and Men indicates how the presence of women declines at each step on the academic career ladder: women accounted women for 59 percent of first-degree graduates, 43 percent of PhDs but only 15 percent of grade A full professors (EC 2007).

The increasing presence of women at university requires us to reconsider a commonplace that presents women as less competitive and more ready to do support work, in some cases explained by reference to biology. This view is based on patriarchal patterns, reproduced also by women. In the construction of their identity during childhood, girls and boys decide what they 'want to be'. When their characters mature during adolescence they need to experiment with roles and behaviours by mentioning their interests in technical, vocational, scientific and humanistic studies. When career choices are made at school, students are often unaware of the total range of options that are open to them.

> *'Science curricula in particular are gender-biased. Science textbooks do not relate to women's and girls' daily experience and fail to give recognition to women scientists. Girls are often deprived of basic education in mathematics and science and technical training, which provide knowledge they could apply to improve their daily lives and enhance their employment opportunities. Advanced study in science and technology prepares women to take an active role in the technological and industrial development of their countries, thus necessitating a diverse approach to vocational and technical training. Technology is rapidly changing the world and has also affected the developing countries. It is essential that women not only benefit from technology, but also participate in the process from the design to the application, monitoring and evaluation stages.'* Statement of the *Fourth World Conference on Women, Platform for Action* (United Nations 1995)

Although a strong effort has been made over the past decades to avoid sexist language use in education and science, a solid image of science as a 'masculine job' is still pervasive (Calloni 2009). It is thus necessary to introduce innovative instruments provided by experts in gender studies to teachers in order to change the **hidden curriculum** that creates a scientific bias between women and men and perpetuates the transmission of stereotypes, often involuntarily, to students. This kind of process has a negative impact on the lives of both women and men and on society as a whole.

5.3.2 Educating young researchers: Towards a more attractive science

The decreasing interest of young people in science can have different roots from early socialisation in the family up to education and socio-economic transformations, as considered below. This lack of interest might be partly explained as a consequence of science teaching. Science is often taught in secondary school classes with old standards, when science was considered as 'reliable knowledge' able to develop exact analytical and technical skills in the process of modernisation. The (natural) science subjects were also meant as a space for the selection of a small minority of students who would enrol at university and later become part of the elite. Curricula contents still reflect elitist assumptions influencing the public education framework where contemporary debates are neglected or non-existent. For instance, there are increasing discussions about the ethical, legal and social implications (ELSI) of technology and science but these issues rarely reach the secondary school level. A constant exchange of information between teachers and researchers is crucial in order to provide an updated view of science and the related problematic. Inter-generational gaps are widening and difficulties are increasing due to the affirmation of the information society. Young people live in an internet- and media-driven society, while some teachers may lack some of these skills. Therefore, for the first time in the educational domain, the asymmetry of information and expertise is increasing between students and their teachers, where the latter are less informed than the former, not least about the role of science in/and society. The issue of communication in science (Ch. 6) thus becomes crucial in understanding the changing public meaning of science.

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Figures should be determined by a qualitative approach to what society expects from science, technology and research. The question is not only how many *but* what kind *of scientists are needed, how do they have to be trained, what do we expect from them, and why are they essential?*

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Motivations that can explain the **decreasing interest and social prestige** of science are various: relatively low incomes compared to those in private business, precarious contract situations, dependence on external funding, frequent evaluations, de-motivating competition, efforts for fundraising and administration, continuous mobility, considerable work burdens going beyond the working hours per day regulated by contract.

These working conditions could make easier the difficult choice between scientific career and family. Young researchers remain in strongly unstable work situation, often until their mid-thirties, living from one grant to the next in assistant positions, hoping to have made the right choice and to be able to get a more stable position. As a consequence, the decision to start a family becomes difficult. Junior research positions demand a high degree of adaptability. In cases when young researchers adopt risk-reducing behaviours, they look for a different job in the private sector or as public servants. These options yield results in the form either of a more consistent income and promotions in a shorter period, or of a stable position, while the beginning phases of a scientific career offer none of these advantages.

So, if young researchers have more attractive alternatives to scientific careers, why should they choose science and why does society want them to do so? As mentioned at the beginning of this chapter, education and research have to be considered as a matter of strengthening potentials in a fair society. This approach is also crucial for disabled young people looking for equal chances, so that their physical disadvantages do not prevent them from developing their capabilities. As stated by Article 26 of the *Charter of Fundamental Rights of the European Union:* 'The Union recognises and respects the right of persons with disabilities to benefit from measures designed to ensure their independence, social and occupational integration and participation in the life of the community.'

The MASIS expert group emphasizes that the increasing number of scientists needed in Europe is not a 'quantity' *di per sé* because figures should be determined by a qualitative approach to what society expects from science, technology and research. The question is not only *how many* but *what kind* of scientists are needed, *how* do they have to be trained, *what* do we expect from them, and *why* are they essential? The political and public debate about *how many* scientists are needed in the EU is in fact oversimplifying the meaning of science and its impact on society because it is rather narrowly conceived as a matter of 'natural sciences and technology'. Social sciences, humanities and arts have rarely been the subject of these debates. This rationalistic bias favouring natural over social sciences - conceived in modernity together with the distinction between body and mind - might be due to the conviction that: (a) science should primarily contribute to Europe's global economic competitiveness, and (b) natural sciences and technology are the decisive factors for reaching prosperity. As we have argued, this is simply not the case because: (1) global problems require cooperation between all scientific disciplines; (2) science is difficult to conceive of without its social dimension; (3) economic development always refers to the development of human potential and fairness. Therefore, the development of policy options requires a clarification of the normative expectations about the futures of science in society.

If we think that it would be enough to revert mainly to formal regulations (e.g. work time or incentives, etc.) in order to influence the choice of young generations, we could lose the opportunity to reframe the social meaning of science and the importance of strengthening potentials. Science is not a 'mission' or vocation. It is a human activity that can have fruitful results for individuals and societies. However, for various reasons it has become exclusive and repulsive for many younger people, precisely at a moment when knowledge societies require high quality academics and scientists who are able to innovate the knowledge domain and to transfer sophisticated technologies.

5.3.3 Minorities: towards diversities as richness

The motto of the European Union is: 'Unity in diversity' where diversity is meant as a common resource more than a matter of segregation and exclusion. However, diversity refers here to the **multiplicity of cultures** composing the various communities and nation states within the EU borders (Ch. 2.3.2). What are the implications of this for science? It is true that the *rationale* of the European Research Area (ERA) is to bring together scientists and to enable them to interact in a new common space, even if they come from different cultures and disciplines, or are not necessarily EU citizens. The ERA should be an inclusive sphere embracing also disadvantaged and discriminated minorities (like in the case of the Roma). All human beings have potentials and the productive expansion of the ERA depends on the development of potentials of all individuals.

Without any doubt, 'diversities' have introduced different views into the Eurocentric knowledge perspective, inducing a self-criticism and the awareness of the necessity of enlarging the scientific field to other cultures. A model of 'democratic' science (Ch. 2.3.4) should thus develop more articulated inclusive practices in order to avoid discrimination determined on the basis of age, culture, origin, gender, sexual orientation, genetic features, ethnicity, etc. As intersectional research on gender has pointed out, exclusion or marginalisation concerning different groups who have, for instance, different religious and cultural backgrounds, as shown by the scarcity of researchers of Roma origin or of the Muslim faith.

Innovative science policies should take into account the new scenario of diversities in order to shift **from *discrimination* studies to *transformative* studies**. The latter are based on a critical self-inquiry and the interest in facing social problems, linking education, research, civil society and other institutions. Innovative science policies should also open up for more cross-disciplinary studies, which might attract more young people who often react against narrow scientific disciplines.

The scientific system should thus be attractive to young citizens belonging to cultural minorities for the following reasons, in accordance with the values presented in this chapter: (a) to respect ethical and equity principles, (b) to promote social integration, (c) to develop the creative potential of all individuals, (d) to consider cultural diversities as a common resource.

5.4 Challenging futures

In this chapter we have indicated why it is important to promote an 'inclusive science', but we have not yet answered a basic question: Why is it important or interesting to pursue a scientific career, when traditional disciplines seem to be in crisis and re-contextualisation is needed?

Without any doubt, the scientific educational system is starving for reform. Curricula development should reflect the growing **interdisciplinary and intercultural nature of sciences** and be updated, starting from the textbooks. Most importantly, science reform must include primary, secondary, vocational and higher education in order to develop more collaborative practices among different levels and learning processes (as the example of the discrepancy in the use of new technologies between students and teachers shows).

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The problem is not the promulgation of new equal opportunities legislation but more effective implementation which could be enforced by severe monitoring and measuring procedures.

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In addition, the encouragement of cooperation between the stakeholders (Ch. 3) in education and research is crucial. Universities and research centres should institutionalise the possibility for secondary school students to visit laboratories and participate in experiments that cannot be observed elsewhere, especially since schools lack the basic infrastructure for performing even some basic experiments. This orientation practice would be of great value for stimulating the curiosity of future generations of scientists, who can see their education as a continuum of learning processes. A stronger interaction between teaching sectors and research centres should be supported by activities of orientation, communication and by new institutions. Science is also a matter of 'closeness' and accessibility, and close contact with it is necessary in order to dispel the image of laboratories as remote, inaccessible and alien spaces.

At the same time, the scientific career has to be conceived differently: research activities permit the acquisition of skills that can be employed elsewhere and not necessarily restrict one to academia, because science is embedded in society. Research and higher education thus need a multi-scientific and inter-cultural approach to issues of common concerns.

The MASIS expert group considers the need for more scientists in the EU in a qualitative way, mainly in terms of the development of capabilities and the strengthening of potentials of involved researchers and social actors. Accordingly, on the basis of geo-political and economic changes, innovative scientific policies are needed for the inclusion of target groups.

Regulation and best practices of equal opportunities have been adopted by all EU governments. Thus, the problem is not the promulgation of new equal opportunities legislation but more effective implementation which could be enforced by severe monitoring and measuring procedures. Three main areas are highlighted below:

First, the development of **sensitivity to gender issues** and social inclusion in education is crucial for all stakeholders from the early phases, including training for teachers in learning curricula.

Second, scientific **careers should be sustainable both for women and men** in the balance between professional duties and private life. The traditional audit logic has to be revisited to make these changes sustainable. Mechanisms are need to support the spread of good practices around the EU.

Third, **educational reforms** are a key-issue for counteracting the declining interest of younger people in science. In order to help young people to define their interests and better understand their choices, orientation and information activities have to start very early in school. Information on the social meanings of science and technology, ethics and social justice should thus also be provided.

In relation to all of these areas, at the same time the EU needs to **ensure fair access** for interested students to all scientific disciplines, supporting talented and motivated students to undertake and pursue a scientific career. A stronger interaction between the teaching system and science centres should be supported so that the ongoing transformation of science can reach education at schools, and here science should be understood in its broadest sense so that youth initiatives are not restricted natural sciences and engineering.

Various means of communication should be employed, as argued in the next chapter, in order to create an adequate picture of science in the eyes of younger people. Schools, research centres and other *ad hoc* science communication all have a role to play in moving beyond the 19th century image of science.

Finally, science becomes more attractive, innovative and productive when it is open to diversities and is inclusive of different perspectives and interests. The development of capabilities has a potential for social transformation, when creativity and freedom can be expressed. Involving people with migration backgrounds in science and technology will be a major issue in the coming decades in relation to the principles of social justice and inclusion.

The issue of **minority balance should be high on the EU science policy agenda**. *De facto* demographic changes have already resulted in a transformation of the European population, so that encouraging a fairer involvement of minorities, political refugees and non-EU citizens in research needs to be addressed by EU science and social policies.

Chapter 6 – Science Communication

Science and technology are central to knowledge-based economies and societies. As a consequence, the dissemination of science and technology and broad public engagement with its development are also central. It is thus vital to recognize the multiplicity of publics created in the processes of communication and interaction as well as the diverse communicators involved and the contexts from which they speak. Understanding science communication as an integral part of the process of producing and exchanging knowledge means that problems cannot simply be regarded as closed after communication and engagement exercises have happened. Problems necessarily remain open as contexts and understandings shift. Even though we may think in terms of a common European Research Area, it has to be acknowledged that communication of this knowledge in more local contexts may differ fundamentally according to socio-political cultures. Furthermore, better understanding of communication within such participatory settings is needed in order to make them truly inclusive. Given the fact that what is at stake in science communication is not simply the education of citizens but also the construction of meaning and design of techno-scientific futures, the citizens, scientists and science communicators actively have to face new forms of responsibilities.

6.1 From transmission to transaction[9]

Throughout the 19th and 20th centuries, people living in European countries have reaped the benefits of scientific advancement, not least due to major improvements in health and longevity and the growth in size and diversity of economic activities. The means of communicating the results and activities of science and scientists have also increased. In the 19th century, large public museums, public experiments and world exhibitions all offered people a chance to see and learn about the latest scientific and technological breakthroughs.

During the 20th century, education became available to a wider range of social groups. Later, the rise of mass media, especially radio and television, offered many opportunities for the public to learn about science. Throughout the history of modern science, the reasons for scientists to communicate about what they did and the means for doing so were quite straightforward. The public (often seen as a largely homogenous group) had opportunities to marvel at science in museums and fairs, to learn the basics at school and to experience technological change in their workplaces. Science and technology were widely accepted as driving forces for progress. The actual work of science and the choices about its future directions remained in the hands of scientific elites (Felt 2000).

By the second half of the 20th century this had begun to change. Governments and scientific establishments wanted the public to understand science in order to function in a satisfactory manner in a growing number of techno-scientific contexts as workers, consumers and patients. In order to understand science, it needed to be taught in schools and communicated via the mass media. In that sense, science became deeply inscribed in contemporary societies and became a

[9] We borrow this title from Hanssen and van Katwijk (2007). For a brief analysis of the different phases from communication to engagement see Felt (2002).

central functioning principle, i.e. science became a way of thinking, a method of approaching problems and an ‘ideal’ functional system. The public committed to the scientific enterprise simultaneously became a force of support for science against direct political intervention.

In the 1980s this gave rise to what is now referred to as the **Public Understanding of Science (PUS)** movement, which mainly embraced a fairly simple communication **transmission model**: sender (science) via transmitter (education, media) to receiver (public) (see *Figure 2*). This was based on a deficit model (Wynne 1991) of learning and education: people are empty, imperfect vessels waiting to be filled with good information. But there are clearly problems with this model, both in theory and in practice. From the perspective of scientists, it seemed that the public did not really understand or appreciate science as surveys in many countries repeatedly demonstrated: many people do not grasp simple scientific facts (Special Eurobarometer 2005). From the perspective of the public, science was too complex and too remote until people were suddenly confronted with major illness or plans for a waste processing plant in their neighbourhood were made public. In such cases, people often demonstrated an impressive capacity for appropriating the necessary science for their own needs.

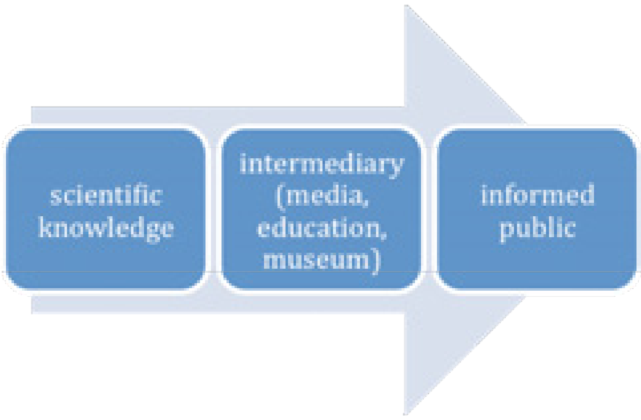

Figure 2: Public Understanding of Science: Transmission of information and knowledge

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The starting point is that scientists and the public can learn from each other, that both have access to knowledge as well as having political and normative values that are relevant for scientific choices.

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> *‘People will pick up the knowledge they need for the task at hand, use it as required, and then put it down again. It will not be ready to hand when the survey interviewer next asks them if, for example, an electron is bigger than an atom.’* (Miller 2001, p.118)

From the perspective of some political parties and civil society organisations – and also from thinkers such as Habermas (1968) who already began to postulate public engagement in defining the scientific agenda in the 1960s – decision making about science had become too politically sensitive to be left to the experts. Since the 1980s, this democratic turn has resulted in greater effort to attempt **public engagement in science** connecting science and the public in dialogue. This takes different forms, ranging from interactive public understanding activities to deliberative processes and actual input into decision making. This **transaction** model differs crucially from the transmission model in that it involves a more symmetric, though not necessarily more equal, notion of communication. The starting point is that scientists and the public can learn from each other, that both have access to knowledge as well as having political and normative values that are relevant for scientific choices. The model recognises that scientific knowledge is necessarily provisional and subject to change. So, this transaction is an ongoing exchange of information, debate and knowledge that becomes an **interaction.**

In this chapter, we focus on current and future dynamics in science communication, moving beyond the benefits of scientific advancement as articulated in the *Universal Declaration of Human Rights* quoted at the beginning of this Report, to understand how scientists and the public participate in scientific discussion and decision making, which is implied in Article 27. In this chapter science communication implies natural and engineering sciences, as most of the debates and controversies revolve around these issues. Yet it seems essential to note that broader communication of social science and humanities has so far been deeply neglected, while at the same time this knowledge shapes contemporary societies in powerful though sometimes invisible ways. Economic and social models, educational reforms, the ways in which we tell our histories are but a few examples where such public reflection and scrutiny by media is greatly needed.

For the social sciences and humanities, the question of who should take part in **public debates** concerning the objects of study and what counts as knowledge is quite open and people are generally quite willing to claim the right to participate. With the natural sciences and engineering, however, it is far less clear who should be allowed to participate and on what terms. Contemporary science is deeply entwined not only with the definition of scientific and social problems but also with the definition and provision of solutions to those very problems, such as what it is to be human and healthy, how to tackle climate change, and how to create sustainable agriculture.

6.2 Communicating science – Why and what?

Communication between science and society aims to inform the broader public about issues related to science and technology, and it informs science about societal perceptions and expectations. It makes scientific expertise publicly visible, sets the agenda of policy making, affects the legitimacy of research, and plays a major role in the governance of science, technology and risk. At the same time, communication is also a source of misunderstandings and misuses: over-simplified models and concepts about how science and society communicate, unrealistic expectations on both sides regarding the benefits of communication, and forms of communication that increase the distance between science and its wider audiences rather than 'engaging' them. Science communication may help to establish a more transparent and open form of two-way communication that contributes to defining the mutual roles of science and society allowing scientists and policy makers to understand public perceptions and understandings of science while simultaneously enabling society to make use of scientific knowledge.

Until relatively recently, scientists were not really expected to communicate beyond providing expertise for government decision making on, for example, energy, transport and healthcare issues. In many countries, popularising science was viewed with suspicion by scientists themselves, at best something to undertake in one's spare time or retirement. The view amongst scientists was, and still is in many cases, that 'real' scientists stay in the labs, doing science and communicating with their students and their peers via both formal (education, publication) and informal (conference, discussion) means.

Times have changed. A survey of an international team of science communication researchers reported (Peters et al. 2008) that **relationships between scientists and journalists** are now more frequent and far smoother than the 'horror stories' scientists routinely share(d) between themselves. Scientists are beginning to see the rewards and not only the pitfalls in this process. Moreover, more than half of scientists surveyed found their latest media appearance to be a 'mostly positive experience', while only six percent were unhappy with the outcome. The change in scientists' attitudes and behaviour is partly driven by the prospect of rewards. The more visible science is the more credible it becomes to potential funders, and even if news coverage does not enhance individual scientists' career prospects at least it makes the work appear more relevant. Another driver is that scientists hope for greater public understanding of the scientific enterprise through news coverage of research. In this sense, the MASIS expert group concludes, science communication too often remains little more than a public relations exercise for science, often deploying great promises about future developments without bothering to provide a more nuanced account of what research is and what scientific knowledge and technologies can achieve.

This relation between science and journalism is far from easy as a recent *Nature* special on Science Journalism reflects (see quotation below). It addresses the tension between the above-mentioned 'supportive journalism' and the need for media reports to provide an external sceptical view. Yet with major restructuring occurring in the media industry the latter kind of journalism seems under threat. What can scientists do to help?

> *'Some will see science journalism as an ally, useful for shaping the public's understanding of science-related issues such as nuclear proliferation, stem cells or genetically modified crops — and, not incidentally, for making the case for a thriving research enterprise to public and politicians alike. (…) A minority, moving beyond perceived self-interest, will point to the deeper value of journalism, which is to cast a fair but skeptical eye over everything in the public sphere — science included. (…) At the moment, unfortunately, journalism's future is far from clear. (…) However, scientists can help ensure that reporting about science continues to be both informed and accurate. (…) The scientific community should work with journalism schools and professional societies to ensure that journalism programmes include some grounding in what science is, and how the process of experiment, review and publication actually works. (…) Science and journalism are not alien cultures, for all that they can sometimes seem that way.'*
> (Excerpts from the editorial of *Nature 2009*)

However these changes in the relation between science and communication activities also have to be understood as being embedded in major shifts in the decades following World War II. Increasing public, political, ethical and moral concerns about, among other things, pollution and civil and military uses of nuclear energy emerged, leading to narratives of failure 'consolidating all unpredicted and embarrassing events under the label "unintended consequences"' (Felt et al. 2007). This is, then, considered as the driving force for the public to argue for communicating with and about science. In addition, as governments became worried about their budgets, the reclusive tendencies of science and scientists began to change. Scientists, especially those funded by public money, are increasingly called to account for what they do and how productive they are (cf. Ch. 4.2.1). Not only the public and their elected representatives started to demand accountability of spending public money, scientists themselves recognised that they needed to do something to allay anxieties about science, its uses and impacts.

Governments, in line with the narratives of techno-scientific progress and its importance for economic development, often want people to know about science for embracing individual, regional, national and European economic competitiveness. In an ever-growing **knowledge-based economy**, people are supposed to understand more about science and technology in order to be effective entrepreneurs, workers and consumers. Governments, politicians and civil society organizations also want to make the public aware of new developments.

6.3 Communicating science – By whom, to whom and how?

As Chapter 3 has already suggested, there are **many actors engaged** in, or potentially engaged in communicating science. Depending on the actual topic, publics can include different configurations of people in their multiple roles as citizens, farmers, workers, patients, transport users, home owners, environmental activists or scientists. But there are also **many scientific information providers** or senders as the basic transmission model calls them. They include individual scientists, formal groups of scientists such as national academies of science or national and international disciplinary associations, science-based companies and industries (e.g. pharmaceuticals), science and education policy makers, publishers, schools and universities. Some of them, e.g. educational institutions, are also transmitters of knowledge. Actually, all stakeholders (cf. Ch. 3.2) are involved in science communication. Though it is not possible to capture the multiplicity of such places of engagement with and exchange over science, the expert group draws the attention to the different perspectives, dynamics and concerns these different groups have.

In addition, there are **many information transmitters** and many locations where knowledge about science and scientists can be communicated, including schools, universities, museums and science centres (see *Figure 3*). Indeed, more recently universities have gained a central role in building the European Research Area through research and education of the next generation of researchers. At the same time, universities became important places where techno-scientific advances are communicated in a broad sense and beyond the individual field of study in a reflexive manner. In this setting, students gain an important role as societal multiplicators.[10]

[10] See for example the symposium organised by the German *Stifterverband* (2007).

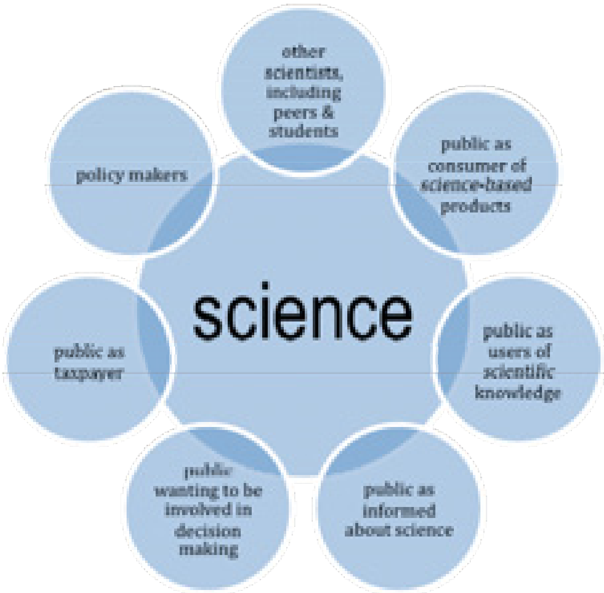

Figure 3: Addressing Many Publics

Different media – newspapers, magazines, books, television, radio, film – are involved as key players, each medium aimed at different audiences and subject to different temporal and structural dynamics. Science is not only communicated via factual and documentary reports but it also plays an important role in fictional representations. The implications for citizens who seek information are reflected in both the *Case study* as well as *Figure 4.* Both show the competition as well as the complementarities between the different formats in which information is presented, the temporal structures through which information is available and the changing needs that make people seek and become interested in scientific information.

Case study

Jane has been taking hormone replacement therapy (HRT) for five years, and it has made her feel much better, relieving the most acute symptoms of menopause. A friend recently gave her a copy of a popular women's magazine in which there was an article about different treatments for menopausal symptoms. The article discussed some of the risks associated with taking HRT, including an increased chance of breast cancer. Jane visits her family doctor for her regular check-up and a repeat prescription but she also wants to know what he thinks about the long-term risks of HRT. While at the doctor's office, the nurse performs a breast examination and gives Jane some leaflets about it. Jane is especially concerned as her sister was recently diagnosed with breast cancer, and she has been spending a lot of time with her sister recently. There are several types of communication going on here: between Jane and her friend, between Jane and her sister, between Jane and the doctor and nurse, between Jane and the leaflets and the magazine article. The leaflets were prepared as part of a national health education campaign. The article was written by a journalist, living hundreds of kilometres away. The article conforms to the magazine's editorial policy about how to report research results, a policy which is different from that of the *Journal of the American Medical Association*, which Jane does not read. The situation becomes more complex when Jane sees a chat show on TV where a famous actress talked about how HRT had changed her life. Jane goes online to look at some of the websites mentioned in the magazine article, in the leaflets she received from the nurse, and at the end of the chat show. From those, she starts clicking and linking, what we now call 'googling'. When she tries to do this again with a friend in her local library, she cannot find some of the information she had found when using her computer at home. The local library has installed filtering software on its public access computers to prevent children from encountering pornography and sex education information, but neither Jane nor some of the librarians are aware of the presence of the software or its impact on access to health sites, arising because health and pornography share an interest in the human body. This simple example illustrates how old and new media (in this case, magazines, leaflets, television, internet, computer software) as well as places (the home, the library, and doctor's office) can play a role in mediating health information. Technologies, people and places mediate information and people's understanding of it. The ways in which they do so are more or less visible to those looking for information.

Adapted from Wyatt et al. (2008, p.2)

Figure 4. Public Engagement with Science: Individual perspective

Moving beyond the level of individual positioning towards science or information seeking to make choices, in recent years, there have been many attempts to organize dialogue or deliberation exercises involving diverse actors. Here the challenge is to decide who will speak in the name of society, so it is also crucial to understand how those participants actually build their positions, what resources they draw upon and how various lifeworlds get intertwined with techno-scientific developments (*Figure 5*). It is essential to realise that techno-political cultures vary enormously across Europe, concretely in the availability of reflexive media discourses on science, in traditions for expressing disagreement, in the presence of strong industrial or civil society players or in the capacity to recognize and acknowledge diverse voices in the political arena.[11]

[11] For a comparison of the ways people perceive and position themselves towards biomedical technologies in different national contexts see Felt et al. (forthcoming).

Figure 5 - Public Engagement with Science: collective dimensions of positioning

Yet as the report on *Taking Knowledge Societies Seriously* (Felt et al. 2007) has stated, the publics to be addressed are not simply out there, fully formed. They become formed and performed through the very activities of communicating science. The most recent public which has attracted much attention in EU and national policy discourses around science communication are children and in particular girls. Being imagined as potential future scientists (see Ch. 5.3), science educators, policy makers and scientists all express concern that science has lost its attraction: young people choose other subjects and vocations. In this context the danger persists that the deficit model gets applied (i.e. 'young people do not like science because they do not know about it') in a rather unreflective manner and communication efforts are made simply to seduce and make the audience admire science, without prior effort to understand why science as a profession has lost some of its attraction.

Beyond all of the critical appraisal of science communication, we can see how the general public have access to scientific knowledge with mass media being the principal way to disseminate science, with television in a leading position (National Science Foundation 2008). But at the same time, we know less about the more qualitative aspects of how the media transmit scientific issues to society. Nonetheless, there is an impression that the media trivialise scientific news. The 'fast thinking' imposed on audiovisual media, independent of the degree of difficulty involved in presenting complex scientific knowledge, frequently reduces scientific news items to anecdotes and sound bites that may be accompanied by a certain degree of **misinformation** (House of Lords 2000). Science communication obviously means simplification which is not a problem if done sensibly. However, the continuous impact of headlines in the news about astounding discoveries can lead to an anecdotal perception of the real development of research and science if this information is not properly contextualized; especially if we consider the complexity and uncertainty that is inherent in scientific research.

Discourse analysis involves approaches about the use of language and concepts regarding precisely the ways in which scientific knowledge reaches the general public in the information and communication age. Scientific-academic use of language and concepts has been recognized as a specific register with its own norms, patterns and style, affecting not only terminology but also ways of presentation and reasoning through particular discourse genres and procedures. No wonder, then, that the ways in which pieces of scientific knowledge are selected and transformed to be presented and explained to non-experts can be very difficult since it demands rigorous re-contextualising conveyed through discursive and communicative procedures. That is why discriminating between simplification and trivialization in science popularization is not easy.

6.4 Communicating science - The internet age

The entire media industry is facing unprecedented pressure from the internet and the ongoing economic crisis, and science journalism is not immune (*Nature* editorial 2009b). *Nature's* survey of 493 science journalists' shows that jobs are being lost in North America, and workloads are rising the world over (Brumfiel 2009). But as overstretched journalists struggle, new forces are rising. Scientists who blog are becoming increasingly influential, as are the press departments of scientific agencies and organizations. The internet allows both of these groups to reach large public audiences on a daily basis. *Nature's* survey also shows that conventional journalists are increasingly relying on blogs and press releases for story ideas.

The MASiS expert group wants to emphasise that there is not a shortage of scientific information, especially since the explosion of the World Wide Web. Blogs, home pages and open source publishing offer scientists more possibilities for distributing information to each other, and the wider public also has access to unprecedented amounts of information online. The problem is thus not how to increase an already large stock of information but how to increase people's ability to find useful information, to judge what is reliable and relevant for them at that moment, to make sense of the sometimes conflicting information with which they are faced, and then to engage in communication and discussion when appropriate. Media literacy, across different media forms, demands enormous skills from both producers and users of information.

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The problem is not how to increase an already large stock of information but how to increase people's ability to find useful information, to judge what is reliable and relevant for them at that moment, to make sense of the sometimes conflicting information with which they are faced, and then to engage in communication and discussion when appropriate.

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> *'If we could start now, equipped with the World Wide Web, computers in every laboratory or institution and a global view of the scientific research effort, would we come up with the system for communicating knowledge that we have today? (…) No, we would think of a new way, one that would provide for rapid dissemination of results that any scientist could access, easily and without barriers of cost. (…) For the past decade or so, a number of scientists have argued that the World Wide Web offers a way to unlock the gates that was not possible when scientific results were conveyed solely by print-on-paper. Advocates of "open access" argue that research results must be made available such that all scientists can see them and use them, for free, via the Web. (…) Open access can advance science in another way, by accelerating the speed at which science moves. (…)The rise of e-science, where global collaborations generate data in vast quantities, demands the means for*

open and immediate sharing of information. And informal channels such as wikis and blogs that are used for disseminating scientific information that cannot be communicated by journals—including time-critical information—must be accompanied by access to the peer-reviewed literature if scientific information is to be accurately conveyed and interpreted. (…)Scientists can banish the threat of that bane of scientific life—obscurity.' Excerpts (Swan 2007)

The internet is a pervasive research tool for science news and information. In some parts of the world, the internet is second only to television as a source of scientific information among the general population. A 2006 survey in the United States (Pew Internet & American Life Project 2006) benchmarked how the internet fits into people's habits for gathering news and information about science. The survey found that the majority of online users have used the internet as the primary source to look up the meaning of a scientific concept, answer a specific question, learn more about a scientific breakthrough, help complete a school assignment, check the accuracy of a scientific fact, download scientific data, or compare different or opposing scientific theories. Such users also reported more positive attitudes about the role science plays in society and higher self-assessments of how well they understand science.

The internet has the potential to change dramatically the relationship between the providers of information and those who seek for it **bypassing gatekeepers in traditional media**. The internet offers scientists and science research centres the possibility to be in direct communication with the general public interested in science. Many think of the internet as a gigantic encyclopaedia on all subjects, available whenever and wherever people want it and this certainly applies to scientific information. (*Wikipedia* serves here as one of the most telling examples.) However, as the case study above illustrates, the internet itself is a highly structured medium, and people need training to understand how and why some information is easier to find and how this can change over time and across different platforms.

In 1989, when Tim Berners-Lee first started developing what we now call the World Wide Web, he saw it as a collaborative workspace for his fellow scientists at CERN, the European particle physics lab near Geneva. His creation far surpassed his early prediction that the usefulness of the scheme would in turn encourage its increased use. Since the commercialisation of the Web in the mid-1990s, its use has grown far beyond its original user group of scientists.

There are fears, however, that scientists are now lagging behind, as they are proving slow to adopt many of the latest technologies that could help them communicate online more rapidly and collaboratively than they do now (*Nature* 2005). The emerging web is largely being shaped by **dynamic interactions** between users in real time. But many researchers still see publications in the formal scientific literature as the primary means of scientific communication, not least because such publications are often the basis of individual career and wider institutional evaluations. Also, they perceive that traditional ways of publishing ensure the enrichment and conservation of the scientific memory, while the content of the internet remains volatile and perishable. Although the traditional published paper is still accepted as the undisputed information of record, younger researchers in particular are concerned that scientists are missing out on new ways to communicate with each other and with the public.

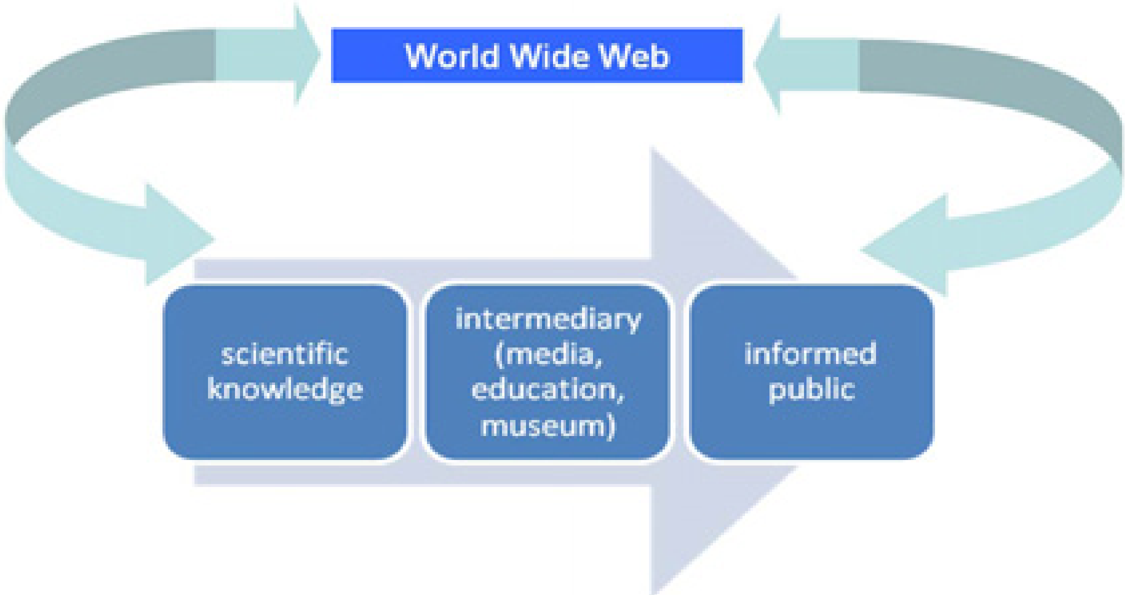

Figure 6 – By-passing traditional science communication

The latest web tools enable scientists to communicate their ideas in new ways, and maybe to reach new publics. To enhance science communication, scientists could make more extensive use of collaborative technologies such as blogs, wikis and websites that any visitor can add to and edit both before publication, when generating ideas, and after publication, when discussing results. But for most scientists, blogs and wikis remain unattractive distractions from their real work. Many consider them an online version of coffee room chatter, background noise that goes against the ethos of peer-reviewed scholarly information. Scientists who frequent the 'blogosphere' see it differently. The dynamic hierarchy of links and recommendations generated by blogs creates powerful collaborative filtering, they argue. Blogs may create noise, but they are also useful for keeping up with the most recent developments in the field. The World Wide Web offers the possibility of by-passing traditional ways of doing science communication without intermediary actors, and in a two-way interaction (*Figure 6*). Yet this new opportunity poses a challenge to both scientist and non-scientist participants: critical capabilities are needed by the public in order to know how to find reliable and useful information, with the ability to identify trusted sources, while scientists are required to be critically self-reflexive and context sensitive to select information for communication.

6.5 *Challenging futures*

Communicating science in ways that are useful and meaningful for both science and society remains a challenge not least because the deficit model underlying the public understanding of science remains very strong amongst (some) scientists, policy makers and the media. The solution is thus not to produce more information about science but to provide it in forms suitable for communication and dialogue.

In spite of many declarations to the contrary, the practice of science communication is still bound to the 'transmission mode'. Public Understanding of Science (PUS) dominates large parts of science communication, with the objective of informing the public rather than engaging with it. The more-or-less hidden goal is to create acceptance and fascination for natural sciences and engineering and thus PUS is a type of marketing in which economic and innovation interests dominate. The ideology behind it can be simply expressed: society should accept science, technology and innovation, and in order to realize a knowledge-based economy more engineers and natural scientists are needed. In this way, science and society do not communicate (communication is a two-channel process) but science speaks to society. In this last section, we identify seven challenges to realising a more productive engagement between science and society.

First, the myth of a singular public that is simply out there waiting to be addressed must finally be laid to rest. There is a **multiplicity of audiences** (scientists, funding organizations, politicians, journalists, NGOs), a multiplicity of reasons for being involved (education, entertainment, deliberation/dialogue) and, thus, a multiplicity of voices (lay and expert, experiential and codified) as well as different types of intermediaries (journalists, teachers, civil society organizations, etc.). The challenge is to require different mechanisms at different times and different training for both providers and users of information, enabling them to choose the most appropriate (set of) means of communication. Scientists experience many demands to communicate, including internal communication with fellow scientists; external communication for purposes of accountability; and much broader communication with the wider public. Complex communication processes are related to all stages of research, such as planning, funding, producing, diffusion, use. Each involves many actors and thus a unidirectional (from science to society) and one-dimensional view of the public is not going to work.

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The myth of a singular public that is simply out there waiting to be addressed must finally be laid to rest. There is a multiplicity of audiences, a multiplicity of reasons for being involved and, thus, a multiplicity of voices as well as different types of intermediaries.

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Second, scientists often regard the public as a large, unknown, risk averse, irrational mass that sometimes behaves unpredictably. Scientists can be very critical about **the role of the media**, of primary and secondary education, and of policy makers. Ethical inquiry, technology assessment (TA) and ELSI (Ethical, Legal and Social Implications) activities are sometimes regarded by scientists as hindering scientific progress or even as dangerous for science because they might awaken the 'irrational' masses. This view has possibly been exacerbated by experiences of severe science and technology conflicts. However, recent developments in the societal debate on nanotechnology suggest there may be positive changes. For some years, nanoscientists, policy makers, and funding agencies have been concerned about the public perception of nanotechnology and a dense programme of communication and deliberation has been put in place. While this can be seen as a positive sign towards increased communication along the stages of the innovation process, there remains a rather widespread perception that if debate takes place in the early stages, there will be no need for further debate in later stages of development. This is nicely illustrated by an editorial in *Nature* (2007) entitled 'Enough talk already'. It stressed that after having communicated and put in place all kinds of deliberative processes around nanotechnology, it was now time to close those activities and put in place adequate policy measures. In reaction to the editorial it was stressed that a one-off deliberation, followed by regulation and then investment in nanotechnology would definitely not suffice, and that 'broader dialogue on notions of progress, quality of life, human needs and our visions of the future — both with and without nanotechnology' should be encouraged (Wickson 2007).

A third obstacle is the strong dependence of **science journalism** on scientific journals and the press releases they generate. Scientific reporting in other outlets often consists of little more than drawing information from professional journals, such as *Nature*, *Science*, *The Lancet* and *The New England Journal of Medicine*. The rigorous review system used by these journals gives more generalist reporters the confidence that these are sources of reliable, thoroughly-researched information. However, the professional journals may no longer be such trustworthy and neutral sources. Medical research is an example, as pharmaceutical companies find ways of publishing their own results in professional medical journals. Thus, all parties involved in communication need training, albeit of different types. Journalists need to understand how scientific knowledge is produced, and what its limitations are. Scientists need to become more skilled in the possibilities and limits of different media for communicating with different publics. The publics need to be both media- and science-literate.

A fourth challenge concerns the **rights and responsibilities of both science and society**. Science communication has become a 'duty' for scientists and a 'right' for the public, a right to know and a right to engage. But the duty is not always welcome and the rights are not always enthusiastically exercised. With the proliferation of public engagement exercises (PES) and two-way communication, new rights and responsibilities have emerged. These have led to a variety of interactions between publics and actors involved in emerging sciences and technologies. There are growing doubts regarding how meaningful such interactions really are (Rip 2008). This is partly a communication issue and partly a governance issue. The expert group suggests putting greater emphasis on public engagement in science (PES) from the communication point of view, with clearly defined responsibilities for actors. For this to be effective there needs to be greater understanding and reflexivity from all parties regarding the nature of science as an on-going activity. There are places to celebrate great scientists and amazing discoveries, but for effective public engagement there needs to be more attention to the choices to be made, the resources to be allocated and the work done by individual scientists as well as research organisations.

Fifth and closely related to the above, as science communication goes well beyond the transmission of scientific findings, it also participates in the production of public meaning as well as in the **construction of potential futures** linked to science and technology, and thus it becomes an issue of responsibility both for scientists and science communicators. Contemporary western societies seem to believe strongly not only that these futures can be shaped, but that narratives about futures are essential resources in deciding on the present (see Adam and Groves 2007). Planning, negotiating and transforming futures and giving a central place to science and technologies in doing so has consequences in terms of responsibility. Being the architects of such futures, both scientists as well as those who communicate science, are accountable for their role in such future-creating activities. Producing wide-ranging promises can thus not merely be seen as a way of obtaining or maintaining a better place in the competition, but has a clear ethical component. The rhetoric surrounding futures is often constructed in terms of 'Mere Possibility Arguments'. Arguments and statements about opportunities as well as about risks are put forward using unclear futures, so that it becomes difficult or impossible to assess the quality of the 'futures' or of the arguments behind them. It is therefore necessary to look deeper into the mechanisms of 'futures communication' in science communication and to develop approaches to enable better deliberation and assessment of such futures. Thus it is essential that spaces are created within science that allow for more reflexive and context-sensitive communication by scientists and thus give scientists an active role in encouraging meaningful reporting of science in the popular media. This is more crucial given that there is nowadays a greater demand for transparency of scientific information and there is a need to engage with research also from within the scientific enterprise.

Sixth, as **web 2.0 techniques** play an increasingly prominent role in communication and interaction, one of the challenges for the science communication domain is to take hold of these tools and incorporate them in PUS (Public Understanding of Science) and especially in PES (Public Engagement in Science) activities.

Finally, while (natural) scientific knowledge has shown a remarkable ability to **transcend borders of politics and language,** there remains a high degree of cultural specificity in relation to science communication. In Europe there are very different traditions and regulations regarding the level of both media and scientific autonomy. These have consequences for how science is communicated within countries and transnationally which should not be ignored or under-estimated. It constitutes part of the richness of Europe as well as of the European Research Area.

Chapter 7 – A European Model of SiS?

The Report has so far reviewed overall trends of science in society, taking into account the developments and lessons learned from the EU SiS programmes. But is there anything specific to these that could be called a 'European Model of SiS'? The European dimensions of trends, cutting-edge issues and especially the wide variety of different forms of governance helped to refine and/or define the European model of science in society. A challenge for the EU FP7 SiS programme and its hoped-for successor(s) is to draw on developments in science-in-society and support further experiments and improved approaches. The recognition of a European model of science in society will be helpful to frame these activities.

7.1 The development of a European model

Regarding governance in general, and ideals of social order, there is clearly a European model, visible in the combination of market liberalism and social welfare ('social capitalism') and the appreciation of cultural diversity. It is recognized as 'the' European model: '*I do think there is much in the European model of governance from which the rest of the world can learn, particularly as we live in a time when very many issues - trade, terrorism, large scale population movements, pandemic disease and climate change to name a few - can only effectively be dealt with on a regional or even global level. Our methods give us a rules-based system through which we can effectively find solutions to shared problems - they are not imposed by a dominant power on its neighbours.'* As this quote from Kallas (2007) suggests, the European model of governance is driven by issues that can be addressed with the help of science. In this respect, the idea of the European Union is based on the belief that the challenges we have to face – be it economic, security, health or environmental issues – cannot be dealt with on the national level, not only because of the global nature of the issues, but also because concerted efforts of politics, science and society are needed to address them.

While there will be specificities to the governance of science in Europe, and to the role of science in society more generally, this need not imply that there is also a European model for science-in-society. In fact, it might be argued that science is international and global, so if there is a model, it should be globally applicable. However, in raising the question of a European model we have something different in mind. There are changes in science-in-society worldwide, but at different paces and shaped by different national and regional contexts. Europe can be a model, not by arguing for one or more specific approaches, but by experimenting and sharing not only the results of experiments but also the processes underlying them.

In this chapter we identify some developments that appear to be components of a European model. Their specificity is often demonstrated by contrasting them with the situation and approach in the US. A clear example is how the European Union has embraced the precautionary principle (since 1999) in contrast to expertise-based regulation favoured in the US. In other cases, as with public engagement, specificities are related to the dynamics specific to the development of such approaches.

In speaking of a European model, we are not implying that there is, or should be, a unified and coherent model. In fact, we already demonstrated in Chapter 4.1 that there are conflicting frames of governance, e.g. of global high-tech competitiveness and of democratisation. A European model may contain a productive mix of the two. Similarly, while there are commonly shared values in the European Union, as the principles of proportionality and subsidiarity, and fundamental rights, such as dignity, freedoms, equality, solidarity and justice (Ozolina 2009), there are also strong differences within Europe. As the recently published METRIS Report (EC 2009a) on European Identity concluded '*the creation and expansion of the European Union has changed some of these divisions. But certain "walls" remain: East-Central Europe vs. Western Europe, Mitteleuropa vs. the rest of Europe, Mediterranean Europe vs. Nordic Europe, core and peripheries of the EU, EU members and others, two-speed EU, etc. The incidence of these differences and the ways of overcoming them are obviously an important issue.'*

An important development for science-in-society in Europe is the establishment and actual functioning of the European Research Area. At the moment, established scientific institutions are active, but the *2020 Vision* (Council of the EU 2009) declared that the ERA is to be responsive to the needs and ambitions of citizens. It should build on mutual trust and continuous dialogue between society and the scientific and technological community. This resonates with projections of a new contract between science and society, as outlined for example by Gibbons (1999): *'a new contract will require more open, socially distributed, self-organizing systems of knowledge production that generate their own accountability and audit systems. Under the prevailing contract, science was left to make discoveries and then make them available to society. A new contract will be based upon the joint production of knowledge by society and science.'* Gibbons was not thinking specifically of Europe, but one might argue that in Europe this new contract is already experimented with and stands a good chance of being realised. The European Research Area might then provide one of the spaces for experimentation.

As this brief discussion of the European Research Area shows, there will be a link – at least, an elective affinity – between the development of a European model for science-in-society and its global transformations, and the quest for a European identity. A similar point has been made by the rapporteur of the Expert Group on Foresighting the New Technology Wave, set up to provide a response to the prominence of converging technologies (nanotechnology, biotechnology, information technology and cognitive sciences) in the policy discourse in the US. Its report, *Converging Technologies: Shaping the Future of European Societies* (Nordmann 2004), was presented as the European approach to converging technologies, and offered a number of innovative approaches to science and technology policy making. Nordmann (2009) argues that these will function as 'a testing ground for European identity'.

Starting from public engagement (the other side, as it were), Horst and Irwin (2009) position the popularity of consensus conferences, and public participation more generally, as a further location where the European Union seeks an identity. Part of their argument is that the consensus conferences emerged, and could only become important in Denmark because of the struggle for a Danish political and cultural identity in the 19^{th} and 20^{th} centuries, and their link with a conviction about innate capacities of ordinary citizens which is also apparent in the tradition of the *Folkelige Hochschule*. Such a conviction is not widespread in Europe, but as an assumption necessary to justify an increased role for ordinary citizens in science-in-society it may become a component of a European model, and reinforce the quest for a European political and cultural identity.

7.2 Emerging components of a European Model

Descriptively, one can identify certain characteristics of a European Model, especially in contrast with the US. One clear difference derives from political cultures: the European commitment to the welfare state, and, linked to this, the acceptance of centralised governance. For science (and technology) this has implied that science (and later technology) policy was seen as an explicit and legitimate domain for national governments which is not the case in the US. The precautionary principle is a case of contention between the EU and the US. The EU decided to introduce the principle in 1999 and it is now part of regulation. The EU has played a leading role in developing anticipatory approaches, with the STRATA projects being an indication of what it tried to do and was able to achieve (STRATA 2002). Participation by citizens, while linked to democracy – which is the main thing in the US – is also seen as a way to improve policy. That also explains why TA in Europe was able to develop varieties of participatory TA.

Science and technology policy in Europe has a benevolent governance character, including recent attempts to assess the functioning and quality of the overall (national) systems. This is also linked to the broader approach to R&D evaluation, compared with the US (Shapira and Kuhlmann 2003). In the age of the audit society, such benevolence extends to having European standards for *ex post* and *ex ante* evaluations.[12]

Embracing the precautionary principle resulted in another difference with the US, which has been felt in its consequences for the role of scientific expertise. As deliberation about the nature of uncertainties and the way to handle them in policy and regulatory decisions become integral to policy making, societal robustness (Nowotny et al. 2001) becomes as important as scientific rigour. In practice, the role of scientific expertise has not changed very much, partly because of the institutional separation of risk assessment (the domain of experts) and risk management (the domain of regulators and politicians).

Contrasts between the US and Europe are not always simple. We use the issue of oversight to discuss two examples in detail.

First, in the case of dual use, already discussed in Chapter 4.2.4, the US tends to go for national oversight mechanisms, such as the National Science Advisory Board for Biosecurity. In contrast, for the same issue, delegated self-governance by the scientific community is favoured in Europe, rather than new legislation. In Europe, with stronger elements of corporatism in its political culture, it is easier for governments to delegate authority to societal actors. The bottom-up approach is of course favoured by the relevant communities, as expressed in the recommendations of a report of The Royal Society and Wellcome Trust meeting in 2004: 'The scientific community should take the lead in determining any codes of conduct or good practice, to pre-empt their introduction through legislation or other "top down" approaches.' A reluctance to pursue legal oversight is visible in a discussion document (Green Paper) on the state of bio-preparedness in the EU, launched by the European Commission on 11 July 2007. One key principle is: 'Tools such as peer evaluations,

[12] In the recently published plans for the next framework programme FP8, it is recommended that European standards should be used, referring to work of the European Evaluation Methodology Network on establishing European standards for research evaluations, both *ex post* and *ex ante*.

awareness raising campaign and supportive financial programs should in the first place be used rather than new legislation.'

Second, consider the demand for more transparency in research, especially relevant in health research. The Helsinki Declaration, World Health Organisation and International Committee of Medical Journal Editors calls for transparency in regard to clinical trials, emphasizing that the registration of clinical trials is a scientific, ethical and moral responsibility. Since 2007, registration is required in the US, and recently also in China and India but not in Europe. In Europe, openness and transparency only applies to studies carried out on animals.

To illustrate further complexity, consider Parliamentary Technology Assessment (PTA) offices. They were 'invented' in the United States, with the establishment of the Office of Technology Assessment by Congress in 1972, but they developed (later) mostly, and in interesting ways, in Europe. Their goals and tasks include the provision of many different types of science policy advice and to support informed deliberation, informing parliaments on questions of scientific and technological progress as well as on innovation aspects; preparing decision makers for future developments by foresight exercises; exploring political, especially parliamentary occasions for action or need for action; developing options for political action; and fostering public debate. Parliamentary TA has been implemented in most of the western and northern European countries for many years (in some, for more than 20 years), also in the European Parliament, in several Mediterranean countries and in some regional parliaments. The institutions form the EPTA network (www.eptanetwork.org) which has been growing (slowly) over the last years. Seen from an EU perspective there should be interest in supporting New Member States by systematically exploring the possibilities for PTA in those countries, with their specific needs, political and cultural traditions relevant to TA, available science and research potentials, etc.

The European-model aspect has to do with how TA in Europe survived (while the US Office of Technology Assessment was abolished in 1995) and was able to develop varieties of participatory TA. By taking part in that movement, some Parliamentary TA Offices were able, eventually, to bridge parliamentary democracy and citizen participation in practice, at least to some extent, and thus contribute to 'deliberative democracy' (Joss and Belucci 2002). Further interesting developments in TA have been presented in Chapter 4.2.5. For Europe, the move to transnational activities is important, like the EPTA Network itself, and the *Meeting of Minds* project which applied the approach of a consensus conference in parallel in nine European countries.

All of these SiS activities can be seen as articulating a European political and cultural identity. Thus, the European model is not just instrumentally important, as a good way to approach science-in-society issues, but also normatively important, as something that indicates what Europe desires to be, and might become.

In the earlier Chapters, we have discussed science-in-society activities and indicated trends and challenges which are apparent everywhere, although in various forms and with various emphases, Here, we have highlighted some which might qualify as components of a European model. Issues of public engagement are just as important in the US as in Europe, and are beginning to be discussed in other regions of the world. Still, there are some elements, in particular the interest in capacity building that remain specific to Europe. European institutions tend ‘to attribute a more active and creative role to their publics – and, as a result, to further encourage such social capacity’ (Felt et al. 2007). In the Science-in-Society session of the EU Conference on the Future of Science and Technology in Europe (Lisbon, 8-10 October 2007), the topic was public engagement in science, discussed in the context of the European Research Area. A distinctive message was the interest in taking ‘public knowledge’ seriously: ‘*Incorporating public perspectives into research can help to bridge gaps between research, policy and the ultimate users and beneficiaries of particular innovations. [...] Across the ERA and its institutions, there needs to be a greater acknowledgement of the contribution that public knowledge can make to the way research and innovation policies are developed.’* (EC 2008b) If this becomes regular practice, it would definitely count as a component of a European model which would go much further in science-in-society interactions than has hitherto occurred in other countries and regions in the world.

7.3 Challenges for the EU SiS programme

Science-in-society activities are supported by policy actors and funding agencies both at the national and the European level. The SiS programme in FP7 is a key initiative, and one of its strengths is that it is generally in accordance with STS and social theory. The funding of SiS has increased from FP6 to FP7, and the number of proposals has increased in parallel, indicating growing interest from a broad array of European researchers. A major weakness of SiS is that it is not embedded in other parts of the Framework Programmes. This endangers the credibility of the SiS logic, and at the same time makes the science-in-society approach isolated compared with other EU-funded research projects.

The willingness of member states to open up to more public participation in science policy and other science-related decisions or to make experiments in opening public access to scientific deliberation varies. Nordic countries, for example, have been willing to use consensus conferences and many other forms of public involvement in science policy debate (Mejlgaard 2009, Mejlgaard and Stares 2009), while others have been more hesitant or resistant. This also has to do with the tension between parliamentary democracy, hard won in some countries, and public participation.

There are some cutting-edge policy issues that are common to some or all member states and could develop further into transnational activities or programs.

- The future of science in society will depend to a great extent on whether the values that unify the EU or the cultural, social and political differences between member states will prevail. The METRIS Report (EC 2009a) stated that the ‘diversity and the resultant complexity of European identity are at present insufficiently accounted for.’
- In line with the above, ‘science in society’ can be considered as part of an (emerging) European identity. Due to the ERA there is more interaction and collaboration between researchers and science institutions, by embracing the diversity of national values, the science in society policy has a potential role in bridging the gap between the EU and its citizens.
- How to increase the impact of science in European policy and society? First of all increased dissemination of all scientific results is necessary, and all means of communication are needed for this purpose, both traditional mass media and new internet-based forms of dissemination. Increased open access to all scientific projects might in principle be the way,

but this requires awareness among policy makers and citizens in general of the potential benefits and risks that can be found in research.

- How to engage more citizens at the European level? This question is still relevant, because even if in principle or in reality open access to all kinds of research activities is established, the amount of information will not be used unless citizens are empowered. This is where education and capacity building becomes very relevant, as a factor that enables people to more easily search for information, understand the messages and act on their own behalf with the help of 'new' science-based information.
- With increased European integration and with a forward look to the establishment of a broad European Citizenship, participatory assessment practices involving European citizens will be important.
- At the European level as well as at the national levels, policy makers and stakeholders are pushing for the opening-up of science and its re-contextualisation. Scientists are also recognizing that the process has started, but they are reluctant to buy into it completely since some scientists think the quality of their mandate will suffer.

SiS as part of the European Framework Programme is not just a funding programme for a particular set of research and support activities. The programme itself, as well as the larger field of science-in-society studies and activities, is also a way to examine and assess the possibilities for an 'adequate place of science in society'.

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