Chapter 17
Socio-Technical Integration: Research Policies in the United States, European Union, and China

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Abstract Research policies in the United States and the European Union have shown increasing eagerness in the last two decades to incorporate insights from publics and the human and social sciences into natural science and engineering research, while Chinese research policies devote relatively little attention to socio-technical integration. The ELSI (Ethical, Legal and Societal Implications) program of the US Human Genome Project functioned primarily as a parallel exercise with little real influence on genomic research practices, but more recent research policies for nanotechnology go as far as to redefine research and development in this field as a confluence of technological and societal research. In the EU, the Framework Programmes for Research and Technological Development show a progressive radicalization of integration discourses and practices. ELSA (Ethical, Legal and Social Aspects) research, for example, which has been conducted since the 2nd Framework Programme (FP2, 1987–1991) in parallel to the natural science and engineering research it studies, has been conceived as a constitutive part of science and engineering research projects since FP6 (2002–2006). Although there are few formal Chinese science and technology policies that encourage socio-technical integration, more and more Chinese scholars from both natural and social science and humanities have embraced the idea of integrating social and ethical concerns at an early stage of science and technology development.

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S.H. Christensen et al. (eds.), *Engineering, Development and Philosophy*, Philosophy of Engineering and Technology 11, DOI 10.1007/978-94-007-5282-5_17,

Keywords Socio-technical integration • Research policy • ELSI • ELSA • Nanotechnology • Framework Programmes

Introduction

High expectations and societal concerns surrounding the heavy investments in new and emerging technologies have opened policy discussions about the roles of humanists and social scientists in national science and technology programs around the world (e.g., Barben et al. 2008; Bennett and Sarewitz 2006; Fisher and Mahajan 2006; Macnaghten et al. 2005). This policy trend calls for and mandates "socio-technical integration" – the incorporation of alternative experts, methods, and perspectives into emerging science and technology programs such as nanotechnology – and goes beyond previous roles for the social sciences and humanities, such as were instituted in the US Human Genome Project (Fisher 2005).

This chapter surveys socio-technical integration (STI) in three prominent political regimes: the United States, the European Union, and the People's Republic of China. These three science policy contexts provide one part of the picture of the state of relations between science and society on a global developmental level. In the case of nanotechnology, the US National Nanotechnology Initiative (NNI) was arguably a key catalyst triggering the global race to harness the envisioned economic and military benefits of nanotechnology, while at the same time, proclaiming an interest in the "responsible development" of nanotechnology. Meanwhile, the EU has attempted to compete not only on a scientific level but also in terms of its ability to ensure "responsible innovation" as a competitive advantage, trying to relegitimize its innovation system in front of European society through policies promoting STI. Finally, the PRC, which claims to have the largest number of publications related to nanotechnology, is paying much less attention than its Western counterparts to socio-technical integration. However, it has lately begun to rethink its science policy from an STI perspective.

To provide more detail with regard to these comparisons, the section on "Socio-technical integration in the United States: the case of nanotechnology" will describe how more recent research policies for nanotechnology in the USA go so far as to redefine research and development in this field as a confluence of technological and societal research. Section on "Socio-technical integration in Europe: European Commission Framework Programmes for R&D" will turn to the European Commission Framework Programmes for R&D, where ELSA (Ethical, Legal and Social Aspects) issues, and publics outside the scientific community, have started being conceived in the last 10 years as dimensions to be integrated into R&D activities themselves. Finally, the last section, "Socio-technical integration in China", will measure the extent to which STI is taking place in China. Even if formal Chinese science and technology policies hardly encourage STI, more and more scholars from both the natural and social sciences and the humanities have embraced the idea of integrating social and ethical concerns at an early stage of science and technology development, particularly in the governance of nanotechnology.

Socio-Technical Integration in the United States: The Case of Nanotechnology[1]

The combination of international competition over the projected economic and technological gains for nanoscale science and engineering – or nanotechnology – and a heightened awareness of the role that societal and ethical concerns can play in the adoption and promotion of innovations led to a hybrid policy for both "rapid" and "responsible" development of nanotechnology. Accordingly, in 2000, the US Congress authored and its President signed into law extraordinary legislative language that mandates (in addition to public engagement and integration) the integration of research on societal concerns with nanotechnology research and development. Specifically, the 21st Century Nanotechnology Research and Development Act (NRDA) of 2003 (Public Law 108–153) requires

> that ethical, legal, environmental, and other appropriate societal concerns, including the potential use of nanotechnology in enhancing human intelligence and in developing artificial intelligence which exceeds human capacity, are considered during the development of nanotechnology.
>
> (US Congress 2003, p. 1924)

At first glance, this language may appear little different from that found in regard to the Human Genome Project's Ethical, Legal and Societal Implications (ELSI) program. The ELSI program constituted what could have been the first "self-critical" US science program (Juengst 1996) and has been adopted and adapted in Europe under the label of "ELSA" (Ethical, Legal and Social Aspects). Despite its innovative character and its role as a model for other forms of social research into science and technology, the ELSI program has been criticized by formal reviews and by scholars for not having interacted sufficiently either with scientific research or science policy processes (Fisher 2005).

The NRDA, however, goes beyond ELSI in listing four distinct means by which the consideration of societal concerns is meant to occur. Here, we focus on the third of the four distinct strategies identified in the law, which largely overlaps with our notion of STI: "insofar as possible, integrating research on societal, ethical, and environmental concerns with nanotechnology research and development, and ensuring that advances in nanotechnology bring about improvements in quality of life for all Americans" (US Congress 2003, p. 1924).

This legal language contains an explicit direction to incorporate, assimilate, and combine social and nanotechnological research. This requirement to integrate research that spans both technological and societal forms of disciplinary expertise – especially insofar as it has the capacity to affect both forms of research – can be thought of as a radical and transformational form of interdisciplinarity: radical because it brings together two disparate forms of scholarship that have been

[1] This section is based heavily on and reproduces portions of Fisher and Mahajan (2006).

differentiated from one another since the ancient formulation of the liberal arts and transformative because of its potential to inform emerging technological developments.

It is informative to consult the official report accompanying the NRDA that was produced by the US House Committee on Science since this helps clarify the objective of the prescribed integration:

> The Committee stresses the importance of integrating research on environmental, societal, and ethical implications with nanotechnology research and development programs to ensure (…) that results of the environmental, societal, and ethical research influences [sic] the direction of ongoing nanotechnology research and development of commercial applications.
>
> (US House Committee on Science 2003, p. 17)

This commentary on the legal language implies that the research and integration activities called for "ought to be able to influence the shape of federally sponsored nanotechnology that finds its way into the public and the natural environment" (Fisher 2005, p. 325).

Evidence that "integration" has been gaining ground in at least some US science policy circles is suggested by a growing trend to incorporate societal considerations into research and development activities, albeit in diverse ways and across a wide variety of contexts. Numerous programs in a variety of science funding and regulatory agencies claim to address societal implications of technological activities, including, but not limited to, the ELSI program, the National Science Foundation's (NSF) "broader impacts" review criterion (Holbrook 2005), Institutional Review Board (IRB) requirements for human subjects research (Sarewitz and Woodhouse 2004), the US Global Change Research "Human Dimensions" program (Janssen et al. 2006), and various President's Council on Bioethics (Briggle 2010). These programs are certainly not analogous, although each claims to supplement technological considerations with societal ones. None, however, goes the distance that the NRDA does in potentially redefining technoscientific research as a collaborative confluence of social and technological research streams.

Thus, as a result of concerns over the public acceptance of nanotechnology and a policy process that signaled a departure from the ELSI model, the NRDA envisioned a new form of R&D in which social, ethical, environmental, and other "nontechnological" concerns and research are explicitly meant to influence the development and direction of new and emerging technologies. But while this radical policy prescription may mark a significant moment in the governance of science and technology in the United States, its implementation is hardly assured. Consider, however, some of the efforts that the NSF has taken and supported in order to realize this policy mandate.

In 2005, the NSF announced several major grants relating to the study of nanotechnology in society (NSF 2005). Included among these was the establishment of two "Centers for Nanotechnology in Society": one at Arizona State University (CNS-ASU) and another at the University of California, Santa Barbara (CNS-UCSB). The CNS-ASU received a $6.2 million award, making it the world's largest center for research, education, and outreach on the societal dimensions of nanotechnology at the time (CNS-ASU 2010). In 2010, the NSF announced that both centers would be renewed for a second 5-year period.

The CNS-ASU pursues a vision of anticipatory governance, which includes the fourfold strategies of foresight, engagement, integration, and their ensembling together in coordinated programs of activity (Barben et al. 2008). The anticipatory governance strategy of integration is largely aimed at increasing reflexivity in the nanotechnology enterprise. The CNS-ASU pursues integration in a number of research and educational forms and venues, the principal one being a coordinated set of more than 20 international "laboratory engagement studies" (Fisher 2007) that span a dozen countries on three continents. This project, called Socio-Technical Integration Research (STIR), is separately funded by the NSF in order to study the extent to which collaborations between social and natural scientists working alongside one another in research laboratories may advance responsible innovation (Fisher 2010; STIR 2009).

The STIR project embeds doctoral students in the humanities and social sciences into laboratories working on a variety of emerging science and technology areas, from nanotechnology and genetics to fuel cells and synthetic biology. These "integration scholars" learn the theory and observe the methods of their natural scientific and engineering counterparts. Importantly, they also introduce an ongoing set of "integration practices" that serve to unpack the social and ethical dimensions of laboratory research in an ongoing, collaborative manner. The integration practices are meant to become embedded in normal laboratory routines and discourses in order to maximize the effects of interdisciplinary collaborations so that these effects can then be studied and assessed in light of the policies and public values that warrant the scientific research in the first place. The social scientists, their methods, and enquiries become part of laboratory research activities during the 12-week period that bounds each lab engagement study.

The types of integrative activities pursued by the CNS-ASU via the STIR project have been found to "trigger changes in laboratory practices – expanding the values and questions considered, and the alternatives that are perceived as viable" (Fisher et al. 2010, p. 1018). For example, as reported in a correspondence in *Nature*,

> reflections on responsible innovation generated novel ideas for antenna structures and nanoparticle synthesis for researchers at ASU's Center for Single Molecule Biophysics. Such developments often advance research and sometimes advance deliberation on public values. For laboratory scientists, thinking and talking about the broader dimensions of their work in an integrated way need not entail a sacrifice in productivity.
>
> (Fisher et al. 2010, p. 1018)

Integration research projects such as the STIR project (Schuurbiers and Fisher 2009) and its cognates at the University of California, Berkeley (Rabinow and Bennett 2009) and at Oakridge National Laboratories (Bjornstad and Wolfe 2011) have different aims and approaches, but generally attempt to conduct innovative, collaborative activities that either assume, question, or demonstrate that "scientific creativity and societal responsiveness can be mutually reinforcing" (Fisher et al. 2010, p. 1018).

Socio-Technical Integration in Europe: European Commission Framework Programmes for R&D

The Framework Programmes (FP) of the European Commission (EC; the executive arm of the European Union) represent the primary instrument for funding scientific and engineering research at the European level. EC research policy has been integrating social and ethical issues with science and engineering at different levels since FP2 (1987–1991). In response to political opposition driven by ethical concerns about a pilot programme on human genome analysis, FP2 implemented an ad hoc expert committee on bioethics in order to address the Ethical, Social and Legal Aspects (ESLA) of research in genomics (Elizalde 1998).

This first ESLA (later ELSA, Ethical, Legal and Social Aspects) research experience in FP2 was followed by regular inclusion of bioethics research in subsequent FPs, where integration became progressively more extensive (i.e., extending across more fields of research). In FP3 (1991–1994), a medical ethics research unit was included inside the subarea of research "Biomedical and Health Research," and inside the "Biotechnology" subarea of research, a series of studies aiming at the assessment of the socioeconomic impacts of biotechnology were supported. In FP4 (1994–1998), ELSA became a common research unit for the three subareas of research (i.e., "Agriculture and Fisheries," "Biotechnologies," and "Biomedicine and Health") included in the research area "Life Sciences and Technologies" (Elizalde 1998).

José Elizalde, the Head of Unit XII.E.5, ELSA-"Life Sciences and Technologies" under FP4, has stated that the integration of ELSA in European research policy resulted in "interdisciplinary projects (…) effectively building bridges between the 'two cultures' of humanities and natural sciences" (Elizalde 1998, p. 13). In the FP4-ELSA website, ELSA research is claimed to promote a "multidisciplinary approach (…) in which a dialogue is established between scientists, doctors, philosophers, theologians, lawyers, social scientists, animal protectionists, consumer and patient groups, industry, etc."[2] However, this interdisciplinarity did not take place at the level of science and engineering research projects, but rather as an autonomous intellectual exercise about science and technology. Therefore, in FP4, ELSA took place, as in previous FPs, as parallel research, instead of being integrated in R&D activities. By "parallel" integration we mean projects studying social and ethical issues that, even if included in, and funded by, science and engineering research areas, function as autonomous, "stand-alone" activities. In FP5 as well, ELSA research was not integrated at the level of core R&D topics (with minor exception), but as parallel "R&D Activities of a Generic Nature" ("Bioethics" subsection) inside the "Quality of Life and Management of Living Resources" research area (i.e., the equivalent to "Life Sciences and Technologies" from FP4).

In the first decade of the 2000s, policy discourse on the integration of ethical, legal, social, and wider cultural issues have become more radical. By "radical" we

[2] http://ec.europa.eu/research/life/elsa/index.html. Accessed March 29, 2011.

mean that social and ethical issues are claimed to be incorporated into science and engineering R&D activities themselves. The Council of the European Union, for instance, stated, concerning the priority research areas in FP6 (2002–2006), that "consideration of the ethical, social, legal and wider cultural aspects of the research to be undertaken and its potential applications (…) will where relevant form a part of the activities under this heading" (The Council of the European Union 2002, p. 7). The same words were reproduced later by the Council of the EU regarding FP7 (2007–2013) (The Council of the European Union 2006).

In addition, ELSA research here is claimed to have become more extensive in comparison to previous FPs, in the sense that this consideration of the socioethical aspects of research is not limited to the realm of the life sciences, but open to any research area in FP6 (The Council of the European Union 2002).

This radicalization of STI by EU policy makers in FP6 needs to be understood in the light of circumstances that provoked a loss of legitimacy of the European science and technology governance system during the 1990s. On the one hand, a series of food crises affected Europe, namely, "mad cow disease" or BSE (bovine spongiform encephalopathy), food and mouth disease in cattle, and dioxin in chickens, which "undermined public confidence in expert-based policy-making" (Commission of the European Communities 2001, p. 19), in the sense that public institutions seemed both unable to control the risks of progress and more aligned with the interests of industry than with the general interest. On the other hand, and fueled in part by these regulatory failures, the European public backlash against agri-food biotechnology from the second half of the 1990s occurred as a reaction by a broad sector of the European publics (environmental groups, politicians, consumer representatives, civil society organizations, farmer organizations, experts, lay public) against what they considered as the uncritical development of a potentially dangerous and unethical technology. In the opinion of these publics, health, environmental, and ethical risks of this technology were being underanalyzed and underregulated in the interest of big corporations (Gaskell 2008). Societal uneasiness with the way in which agri-food biotechnology was being developed stifled institutional and industrial innovation plans, and at the same time, the original regulatory framework became tougher.

The more radical policy perspectives about the integration of socioethical issues in processes of innovation from the last decade are explained in the policy field as responding to an institutional strategy toward the legitimization of the European innovation system. For example, the EC research area "Science in Society" from FP7, which aims "to stimulate the harmonious integration of scientific and technological endeavour and associated research policies into European society" (European Commission 2007, p. 4), subordinates European integration policy to the European Union's strategic goal of becoming "the most competitive and dynamic knowledge-based economy in the world" (European Council 2000, p. 12). This subordination occurs under the assumption that the integration of social and ethical issues in research would facilitate the social uptake of scientific-technological innovations: "For Europe to become the most advanced knowledge society in the world, it is imperative that legitimate societal concerns and needs concerning science and technology development are taken on board" (European Commission 2007, p. 4).

Based on a preliminary analysis of approximately 10 years of European research solicitations, it appears that more radical institutional discourse on the integration of ELSA has been accompanied by an actual transformation of integration at the level of research policy practices. Additionally, we can cite instances of policy discourse on "public" integration. Two examples are Regulation (EC) No. 2321/2002 concerning the rules for participation in FP6, where it is stated that "activities under the Sixth Framework Programme should (…) improve information for, and dialogue with, society" (The European Parliament and the Council of the European Union 2002, p. 24), and Zoran Stančič's (former Deputy Director-General of the European Commission Directorate General for Research) claim, in the middle of the transition FP6-FP7, that "more must be done (…) to find ways of actively engaging with civil society, stakeholder groups and the public at large in the preparation and execution of research" (Stančič 2007, p. 1). In this sense, it is also significant that the "readiness and capacity to engage with actors beyond the research community and with the public as a whole, to help spread awareness and knowledge and to explore the wider societal implications of the proposed work" (The European Parliament and the Council of the European Union 2002, p. 28) was established as a common evaluation criterion of research proposals under every research area in FP6.

A further step in this analysis would be to determine the extent to which these apparently evolved characteristics of STI at the policy level of research solicitations are affecting the way in which scientific and engineering research is conducted in Europe, an issue that has begun to be addressed within the EC (e.g., Braithwaite et al. 2007). However, this is a topic that exceeds the scope of this chapter.

Socio-Technical Integration in China

As a developing country, economic development is China's current priority. It is rather uncritically assumed that science and technology always play major roles in promoting economic growth. Consequently, China's research policies mainly focus on the development of science and technology per se, with little attention to STI.

However, there are some governmental regulations in the People's Republic of China concerning ethical or social aspects of science and technology, especially in the field of medicine and biotechnology. In the newly revised Law on Progress of Science and Technology, it is clearly stipulated that "The nation forbids any research and development activity of science and technology which harms national security, social public good, human health or violates morality and ethics" (National People's Congress of PRC 2008). This is the first time that a Chinese national law established a forbidden zone for scientific-technological activities.

At the same time, the Chinese scientific community has become more aware of the ethical dimension of scientific research. On February 26, 2007, the Chinese Academy of Sciences (CAS) issued two reports addressing this issue: "Declaration on the Idea of Science" (CAS 2007a) and "Suggestions for Improving the Norm Construction of Scientific Research Conduct" (CAS 2007b).

The declaration admits that while science and technology produce enormous spiritual and material wealth, they can also create side effects and challenge established social ethics. This means that scientists need to conduct their activities in a socially responsible way. Scientists should try consciously to avoid any negative side effects of their research activities and be responsible for assessing these side effects. In addition, they should provide adequate warnings to society and change or even stop their research once malpractice or risk is detected (CAS 2007a).

The suggestions set forth concrete requirements in order to improve the academic environment and also to identify and treat scientific misconduct. To implement these requirements, CAS and its affiliate organizations set up a commission for scientific research morality. With these two documents and other relative instructions or codes, CAS has established a relatively comprehensive normative system (CAS 2007b).

In addition to the normative initiatives taken by the government and the primary research community, socioethical dimensions of science and technology are being addressed in higher education, where future scientists and engineers are introduced to and study the social aspects of their activities. In higher education, Science, Technology, and Society (STS) institutes and centers have been established in many leading Chinese universities. Indeed, every Chinese university has an STS teaching section. An introductory course called "Dialectics of Nature" is compulsory for all masters students majoring in the natural sciences, engineering, agriculture, and medicine (Cao 1995). All Ph.D. candidates in those majors have to attend a similar course known as "Modern Revolution of Science and Technology and Marxism." The two courses function as both an ideological and a liberal education for future Chinese scientists, engineers, and physicians, providing them knowledge of basic views on nature, methodology of science and technology, and STS.

Socio-Technical Integration at the Academic Level: The Promising Case of Nanotechnology

There are few formal policies on socio-technical integration at the governmental level. However, more and more Chinese scholars from both the natural and the social sciences and humanities have been realizing on their own the importance of integrating social and ethical concerns at an early stage of science and technology development. This academic trend for integration is evident in the governance of nanotechnology.

Programs and initiatives on nanotechnology in China were started in the 1980s. During the past 20 years, China's nanoscience and nanotechnology research has developed rapidly. To date, more than 50 universities, 20 institutes, 600 companies, and 5,000 researchers have become engaged in nanoscientific research and nanotechnological development (Liu 2009). In 2007, China ranked number one in nanotechnology papers published in the Science Citation Index worldwide

(Zhao 2010). At the same time, the commercialization of nanotechnology is gradually increasing. Although still in its infancy, around 1,000 enterprises are involved in nanotechnology in China (Zhao et al. 2008).

With the rapid development of nanotechnology application fields, the issue of nanotechnology safety has given rise to serious public concern. Learning from European and American experience, leading scientists from the CAS Institute of High Energy Physics (IHEP) suggested in 2001 that the environmental and toxicological impacts of manufactured nanomaterials should be studied (Zhao and Bai 2005). In 2003, the Laboratory for Bio-Environmental Health Sciences of Nanoscale Materials was established at IHEP.

These appeals by high-level scientists quickly drew government attention. In 2004, the highest-level scientific meeting organized by the Chinese government, held in Beijing Fragrant Hill, was about "Nanosafety: Biological, Environmental and Toxicological Effects of Nanoscale Materials/Particles." Currently, more than 30 research organizations in China have initiated research activities studying the toxicological and environmental effects of nanotechnology (Zhao et al. 2008).

All of this demonstrates that safety research on nanotechnology in China has become an increasingly important topic. Yet the concept of "nanosafety" relates not only to technical risk but also to societal risk. In this sense, China lags behind Western countries. This situation began to change in 2008, after the second National Bioethics Conference, as nanotechnology gradually attracted the attention of Chinese social scientists and humanities scholars.

So far, among the efforts made in the STI of nanotechnology development, the workshop on "Nanoscience and Nanotechnology and Ethics" held in 2009 by the subcommittee on Ethics of Science, Technology and Engineering of the Chinese Society for Dialectics of Nature, and the Chinese National Center for Nanoscience and Technology, could be called a milestone. Experts from the natural sciences and the humanities and social sciences discussed together the possible ethical and social issues of nanotechnology. In the end, they reached a consensus that the development of nanotechnology requires the engagement of philosophy and ethics. Even if this interaction between nanoscientists and scholars from the humanities and social sciences does not yet occur at the R&D level, this cross-disciplinary dialogue is a good starting point for deeper STI in future R&D activities in China.

Public Understanding of Science and Technology, and Public Engagement

The relationship between science and the public in China is mostly framed in terms of the deficit model: the public needs to be scientifically enlightened. Experts and bureaucrats are the only actors who make decisions on the development of science and technology.

Nevertheless, along with other aspects of social progress taking place in China, a new trend has been emerging that emphasizes public engagement in the development of science and technology. For example, a public activity on genetically modified foods (GMFs) was held in the Western District of Beijing in November–December 2008. This event was jointly initiated by the Center for Strategic Studies of CAS, Center for Ethics of Science and Technology of CAS, Committee of Science and Technology of Western District of Beijing, and Office of Desheng Subdistrict. Drawing on the model of Danish consensus conferences, it was the first experience of such a public engagement activity in mainland China. The theme of this activity was "Science in Community." A selection of 20 volunteers was made according to gender, age, education, and career criteria. In addition, four experts on STS and science communication participated.

This activity consisted of one preparatory meeting and two formal meetings. During these meetings, citizen volunteers were first provided with basic information about GMFs, ELSI issues, and governance problems. Then, experts and volunteers exchanged opinions and had a discussion on the risks and uncertainties surrounding GMFs. Role play was introduced to improve communication. It was noticed that these volunteers were a little bit uneasy at the beginning regarding critical thinking about science and technology, as they were accustomed to consider science and technology as intrinsically good and absolutely powerful. But soon volunteers began to understand that social, economic, political, and cultural factors are constitutive of any technological product (Li 2009).

This participatory experience was only a first-time experiment for Chinese social researchers. Nevertheless, it was a promising beginning, an attempt to import some European and North American approaches into the Chinese context. All in all, this trial indicated that there is great potential for actively engaging Chinese citizens in science and technology-related issues.

Conclusion

This chapter has surveyed STI practices in the research policy systems of three prominent political contexts: the United States, the European Union, and the People's Republic of China. The analysis points, first, toward some pronounced differences between both the USA and the EU, on the one hand, and China, on the other, regarding STI. In both the USA and the EU, R&D has been redesigned during the early 2000s in terms of a policy demand for incorporating social and ethical considerations in ongoing science and engineering research practices, while in China research policies pay little attention to STI.

In the USA, there is an explicit legal demand to integrate social and technological research streams in nanotechnology R&D activities. In this sense, STI as formulated in the context of nanotechnology research goes beyond former experiences such as the ELSI program, which became institutionalized as one of the components of the US Human Genome Project but functioned primarily as a "stand alone" exercise, not connected to R&D processes.

In the EU, research STI policy, as formulated in the Framework Programmes for R&D, evolved in the early 2000s into more radical forms of integration. This means that socioethical and legal issues, previously pursued as "stand alone" or parallel activities, are promoted as dimensions to be incorporated into science and engineering research practices themselves, in ways similar to that of US nanotechnology research. In the EU particularly, STI is conceived as part of EU's effort for legitimizing its science and technology governance system. This has been questioned most prominently beginning in the 1990s by broad sectors of European publics, which argue that science and technology developments should integrate more seriously the interests and concerns of society as a whole.

Finally, in China, research and development policies are not promoting this kind of strong STI. Due to China's special historical context, economic development is the basic priority, and science and technology are promoted as playing major roles in fostering economic growth. Critical thinking about the possible negative effects of science and technology remains rare, even if some ethical regulations for science and technology have been established both by the government and researchers themselves. Nevertheless, scholars from both natural and social science and humanities have embraced the idea of integrating social and ethical concerns at an early stage of science and technology development. Furthermore, recent experiences of public dialogue on scientific issues may point to the development of more integrated research in China's future.

Acknowledgements Hannot Rodríguez's contribution is based on research supported by the Department of Education, Universities and Research of the Basque Government under a postdoctoral fellowship for the improvement of research personnel in a foreign country (Ref. No.: BFI08.183; 2009–2010 2-year period). This research was conducted at the Consortium for Science, Policy & Outcomes at Arizona State University. The author wishes as well to thank Heather A. Okvat for her assistance during the final revision of his work.

Hu Mingyan expresses her gratitude to Prof. Cao Nanyan for her constructive comments regarding this work.

Erik Fisher's contribution is based in part on work supported by the National Science Foundation under award number #0849101 and under cooperative agreement #0531194.

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