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3.1.1 Researchers' responsibilities and ethical, legal, and social issues （ELSI）

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Abstract

With the end of the Cold War, the model positing scientific research as the production of knowledge based on the philosophy of pursuing the truth, and the possessing the social responsibility to ensure quality control (i.e., not allow research fraud) in terms of production, began to be revised. Today, the knowledge produced by science and technology has an enormous impact on society, and the social responsibility of such activities continues to grow. In the future, science and technology research conducted using social resources, including public funds, will need to consider the social impact of the research, with researchers conscious of their own social responsibility to this end.

Keywords

CUDOS, ELSI, modal theory, Pasteur's quadrant, post-normal science, technology assessment, uncertainty and decision-making in science and technology

1　A review of the changing relationship between society and science and technology

At the risk of sounding overly dramatic, it was not that long ago that human society had groups of people who made their living by creating novel knowledge. It was during the nineteenth century that these groups began calling themselves scientists. Since then, science, which initially had little ability to

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demonstrate its usefulness in the real world, has demonstrated its value through the two world wars of the twentieth century. The subject of tremendous investment of human and economic resources from society, science has come to be regarded as a driving force that supports and drives a concrete social group, even a modern industrial society. Various perspectives have been formulated in an attempt to explain the "success" of science. For instance, the so-called rational "scientific method" has promoted the discovery of truths. Alternatively, scientists themselves conduct their research activities based on a particular sense of value, which makes the discovery of truth possible. Where the former served as the main research motivation of the philosophy of science from the latter half of the nineteenth century, the latter—typified by Merton's CUDOS (Communality, Universalism, Disinterestedness, Organized Skepticism)—is a topic that the sociology of science has sought to explain.

Both perspectives share the understanding that scientific research pursues truth. The application of this truth has long been viewed as belonging entirely to society. At the same time, it was also understood that science had a social responsibility to find the truth. Of course, there have arguments regarding the social responsibility of physicists in the development of nuclear weapons and the Russell-Einstein Manifesto, but they have had relatively little impact on the self-understanding of science as a whole.

In fact, reflection on and change in the self-understanding of science as the pursuit of truth did not occur until the 1970s, triggered by skepticism regarding the optimistic picture of achieving human progress through scientific truths. The negative aspects of scientific development, such as environmental problems (called pollution at the time), became apparent, giving rise to debates about the social responsibility of science and activities like technology assessment, which had never taken root in Japan.

In the 1990s, following the end of the Cold War, the social significance of pure scientific research, which had been conducted under the banner of national prestige and on the basis of massive military research in the United States and other countries, began to be questioned. It is no longer permissible to use blank-check research funds simply on the basis of the argument that research is meaningful in and of itself and that the purpose of science is to pursue the truth. Indeed, according to the 1998 report, "Unlocking Our Future" by the US House of Representatives' Committee on Science, while this optimistic view of science was appropriate during the Cold War, times had changed. The contribution of science to the economy was subsequently emphasized as the primary social significance of science.

In 1999, UNESCO and the International Council for Science (ICSU) co-hosted the World Conference on Science in Budapest, where the significance of science in the twenty-first century was discussed and the World Declaration on Science and the Use of Scientific Knowledge was adopted (The World Conference on Science, 1999). The roles of science in the twenty-first century discussed therein include "science for knowledge; knowledge for progress," "science for peace," "science for development," and "science in society and science for society." In particular, the last section, "Science in society and science for society," emphasizes the social responsibility of science and attempts to rethink the traditional view of science as the pursuit of truth within a larger social context. It is important to note that the idea that "science for knowledge; knowledge for progress" refers to traditional pure and basic science, and not "science in and for society," as typified by engineering.

Nonetheless, it is important to understand that there are not two kinds of science, and that all science exhibits both of these characteristics.

2 Changes in the relationship between society and science and technology in Japanese and European science and technology policies

The change in the relationship between society and science and technology, clearly evident in the 1990s, is also reflected in Japanese and European science and technology policies formulated around the same time. Figures 1 and 2 illustrate the perspectives through which the relationship between society and science and technology is expressed as policy in Japanese and European science and technology policy, respectively. Here, we can see a clear transition and layering in the representation of policy issues. What they have in common is that in the 1980s and early 1990s, the dominant mode of thinking was what we might call the "measurement mode." In other words, they exhibited an interest in measuring how accurately "correct" information about science and technology is "communicated" to society. Various surveys were conducted, and where it was found that the information was not being conveyed "correctly," a "science communication activity" was carried out to publicize and share information to correct this. These activities are known as "science education promotion," "activities to promote understanding" or "public understanding."

Figure 1
Source: Kobayashi(2004)

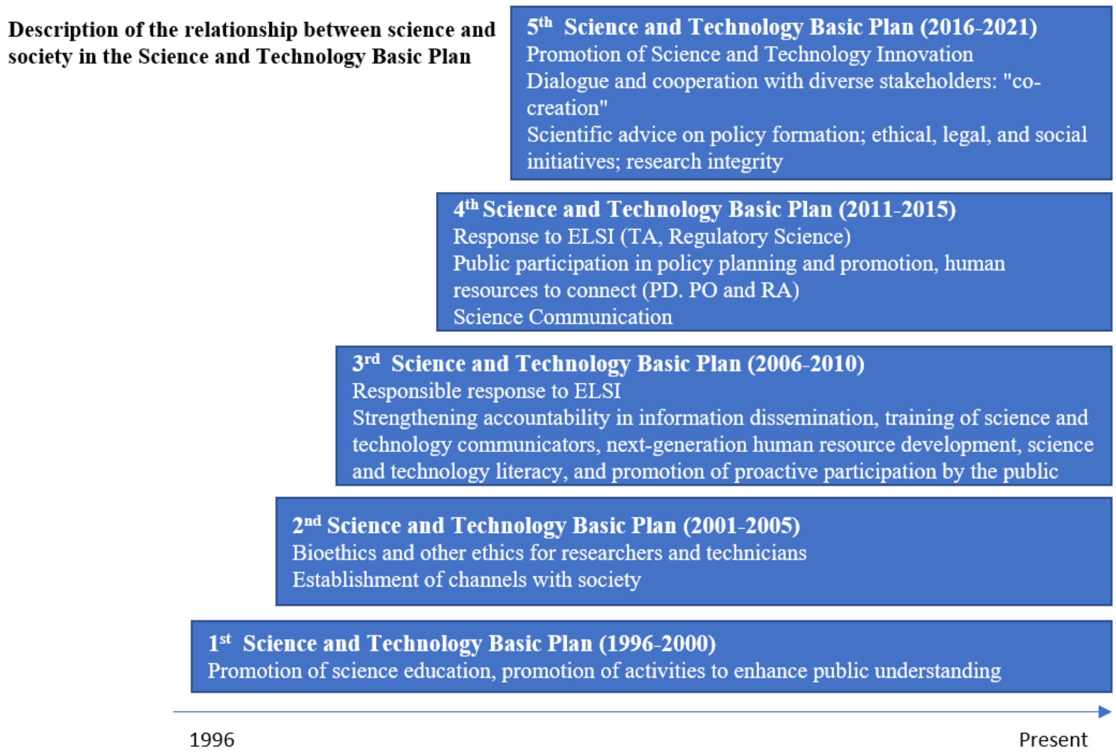
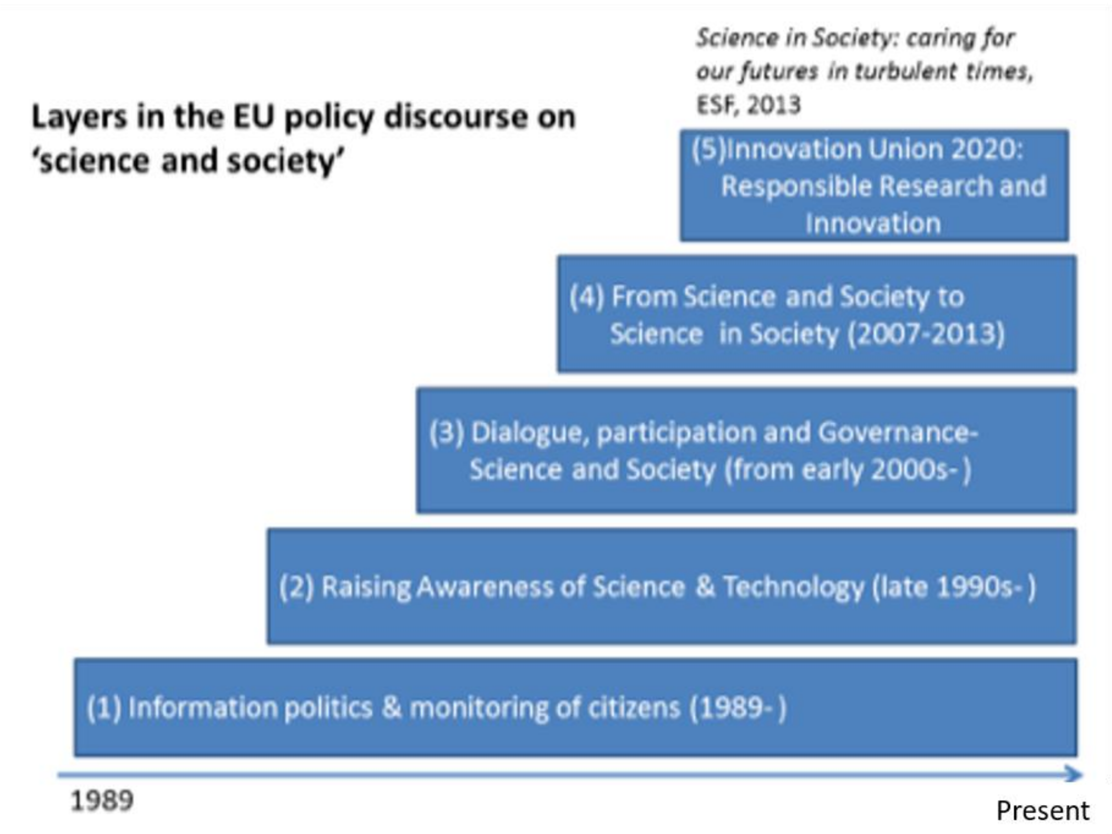

Description of the relationship between science and society in the Science and Technology Basic Plan
5th Science and Technology Basic Plan (2016-2021)
Promotion of Science and Technology Innovation
Dialogue and cooperation with diverse stakeholders: "co-creation"
Scientific advice on policy formation; ethical, legal, and social initiatives; research integrity
4th Science and Technology Basic Plan (2011-2015)
Response to ELSI (TA, Regulatory Science)
Public participation in policy planning and promotion, human resources to connect (PD. PO and RA)
Science Communication
3rd Science and Technology Basic Plan (2006-2010)
Responsible response to ELSI
Strengthening accountability in information dissemination, training of science and technology communicators, next-generation human resource development, science and technology literacy, and promotion of proactive participation by the public
2nd Science and Technology Basic Plan (2001-2005)
Bioethics and other ethics for researchers and technicians
Establishment of channels with society
1st Science and Technology Basic Plan (1996-2000)
Promotion of science education, promotion of activities to enhance public understanding
1996
Present

Figure 2


Layers in the EU policy discourse on 'science and society'
Science in Society: caring for our futures in turbulent times, ESF, 2013
(5)Innovation Union 2020: Responsible Research and Innovation
(4) From Science and Society to Science in Society (2007-2013)
(3) Dialogue, participation and Governance- Science and Society (from early 2000s-)
(2) Raising Awareness of Science & Technology (late 1990s-)
(1) Information politics & monitoring of citizens (1989-)
1989
Present

Source: The ESF Standing Committee for the Social Sciences (SCSS, 2013)

However, around the year 2000, the "dialog mode" began to be emphasized as a result of an increasing number of cases in which the traditional measurement mode became difficult to use, such as the BSE incident, social unrest over life sciences like cloning and genetic recombination technologies, and social conflicts over nuclear technologies. During this period, citizens and experts in science and technology in various countries around the world attempted to engage in dialog. Examples include the consensus conference[2] developed in Denmark as a participatory technology assessment, and the citizens' jury on science and technology modeled on the jury system.[3] It was also around this time that the Science Café—similar to the Café Philosophique, which was started with the idea of taking philosophy out of the ivory tower of academia and into the everyday life of the people—was established.[4] "Science in society" was subsequently emphasized.

While the measurement mode indicates a tendency to seek a "correct" understanding of science by society, the dialog mode indicates a tendency to seek an "appropriate" understanding of society by science and technology. This is not to say that either is right in isolation. Rather, both are needed for a good relationship between society and science and technology. The idea of a "proper" understanding of society by the science and technology side naturally leads to a reconsideration of the mission of science and technology (i.e., of scientists and engineers). In addition to the sincere pursuit of truth, scientists and engineers will be required to examine the various legal, ethical, and social issues associated with the production of scientific and technological knowledge. Initially, these considerations were recognized as pertaining to relatively limited issues in the form of ELSI (Ethical, Legal and Social Issues) studies,[5] and associated with life science research, such as human genome research, or engineering ethics. However, as

2 See Kobayashi (2004) and Wakamatsu (2010) for examples of events in Japan.

3 For more information on domestic and international examples, see DecoNavi, a database of participatory methods and practices, http://decocis.net/navi/. The existence of such examples, both in Japan and abroad, as well as the existence of a group of researchers with experience in conducting such surveys in Japan, made it possible to conduct the enerugi kankyo ni kansuru toron-gata seronchosa (Deliberative Poll on Energy and the Environment) in 2012. The survey report was published by the Executive Committee of the Deliberative Poll on Energy and the Environment (2012). For the views of the researchers involved in conducting this survey, see "The significance and overview of deliberative polls" on the Keio Center for Deliberative Poll website (http://keiodp.sfc.keio.ac.jp/?page_id=22) and Yanase (2015). The Program for Education and Research on Science and Technology in Public Spheres (STiPS, 2014) is a report on retrospective discussions by stakeholders under the Chatham House Rule.

4 See Nakamura (2008) for the history of the Science Café.

5 Andrews, who was in charge of ELSI research during the Human Genome Project, made it clear that Watson wanted a "watchdog g roup that would only debate and not actually take any action" on ELSI; see Andrews (2000, Chapter 12). Moreover, in life science s, a system of control over research has been established through various guidelines, directives, and laws. See "Bioethics and safet y initiatives" on the website of the Ministry of Education, Culture, Sports, Science and Technology (http://www.mext.go.jp/a_men u/shinkou/seimei/main.htm); "Guidelines for research" on the website of the Ministry of Health, Labour and Welfare (http://www. mhlw.go.jp/stf/seisakunitsuite/bunya/hokabunya/kenkyujigyou/i-kenkyu/index.html); and "Guidelines for personal genetic inform ation and bioethics" on the website of the Ministry of Economy, Trade, and Industry (http://www.meti.go.jp/policy/mono_info_ser vice/mono/bio/Seimeirinnri/).http://www.mext.go.jp/a_menu/shinkou/seimei/main.htmhttp://www.mhlw.go.jp/stf/seisakunitsuite/b unya/hokabunya/kenkyujigyou/i-kenkyu/index.htmlhttp://www.mhlw.go.jp/stf/seisakunitsuite/bunya/hokabunya/kenkyujigyou/i-k enkyu/index.html

the interface between science and technology research and society changed, they have come to be recognized as issues facing all science and technology research since the mid-2000s.[6]

3 The transformation of the interface between society and science and technology research

It is not uncommon for science and technology to conduct research in response to demands from society, as was seen in the mobilization of science during the Second World War. Outside times of emergencies like wartime, the CUDOS philosophy of the pursuit of truth rooted in scientists' intellectual curiosity was respected by society. During the Cold War, this view was sometimes advocated on the grounds that it was beneficial to national prestige, as in the US. However, once the Cold War had ended, countries around the world positioned science and technology as a means to achieve economic growth and welfare, and policy guidance for research began.[7]

Perspectives on research funding Contract research is a mechanism for commissioning research to solve social and policy issues, and is described as "mission-oriented research" in contrast to the curiosity-driven research of CUDOS. It is worth noting that the science and technology research that has emerged since the late twentieth century represents a mode that cannot be understood in the model envisioned by the CUDOS philosophy. First, the distinction between basic and applied science does not correspond to the distinction between the pursuit of truth and the pursuit of utility. Possessing the character of basic research, the life sciences are far from oriented toward practicality. Much of engineering research also has this character. In an attempt to capture these points, Stokes (1997) developed Pasteur's quadrant (Figure 3) . Here, truth-seeking research is classified into two types: that which is intended for social use and that which is not.

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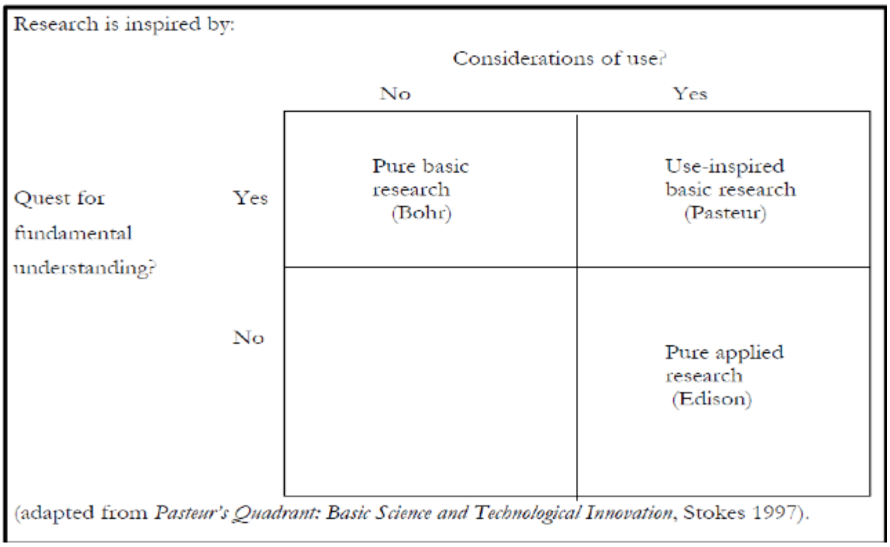
6 See Fujigaki (2003). In light of the historical background of ELSI, see Kamisato (2016) for a discussion of the need for its application to information technology.

7 Gibbons et al.'s "Mode theory" offers a multifaceted analysis of the transformation of the interface between science, technology, and society during this period. If we view this situation from the perspective of Gibbons (1997), the twin pillars of scientific research grants and contract research in Japan, with increasing sums of money provided in the latter, is the result of this trend.



(adapted from *Pasteur's Quadrant: Basic Science and Technological Innovation*, Stokes 1997).

Figure 3

Source: Stokes (1997)

Second, the mutual use of resources between and integration of traditional disciplines has begun to advance at an unprecedented scale. It is well known that, unlike the biological sciences of the past, the life sciences are characterized by integration with engineering and information science, as well as disciplines like nanoscience, photonics, and environmental science. It is evident that we will need to go beyond conventional disciplines if we wish to tackle complex social issues such as energy and environmental problems. The rapid development of information science is also beginning to show the potential to play a role as a research infrastructure science that will change the nature of academia as a whole, that is, in both the humanities and the sciences.

Third, research that uses society as its laboratory is beginning to make progress. In addition to traditional experimental research in the laboratory, research in society has come to play an important role. The first example of this was life science research using large amounts of genomic information, which led to a variety of ethical considerations associated with the acquisition of materials and data from a wide range of people in society. Today, the same issues have gained particular attention in information science. Ethical and legal considerations are inherent in research conducted through the acquisition and analysis of big data.

Researchers are seeking to understand this transformation of the interface between society and science and technology from various perspectives. Gibbons' modal theory and Stokes' discussion of Pasteur's quadrants are just two examples, with others including Ravetz's post-normal science theory (Ravetz, 2010) and in innovation theory, the development of Etskovitz's triple helix theory into quadruple helix theory.[8]

The debate surrounding innovation is of particular importance when considering recent science and technology policy. As economic growth declines in developed countries and social issues—such as increased social security costs due to population aging—continue to grow, various countries are trying to

8 Etskowitz's (2009) triple helix theory is a theory of innovation that focuses on the three elements of industry, government, and academia. However, recent discussion has expanded to a quadruple-helix, which adds "society" as a further element. https://cor.europa.eu/en/engage/studies/Documents/quadruple-helix.pdf

find a way out through innovation in science and technology. Examples include the EU motto "responsible research and innovation," as shown in Figure 1, and the emphasis on innovation in Japan's science and technology policy. Science and technology in particular are expected to contribute to the economic well-being of society, among many other social issues.

From this perspective, the humanities, along with the so-called pure sciences, are the most likely to be the subject of criticism. Debate over the mission of the humanities and social sciences have intensified. In the US, there is talk of a decrease in government research funding for the NSF,[9] while in Europe, the European Research Council has issued the Vilnius Declaration,[10] which emphasizes the importance of the humanities and social sciences in contributing to innovation.

4 The purpose of science and technology

As science and technology come to play a greater role in society, and as their power increases, so do their expectations and responsibilities. Science and technology, in which vast amounts of public resources are invested, are no longer allowed to excuse their activities with lines like, "[it] is an activity based on intellectual curiosity, and does not aim for any particular usefulness." Those involved in science and technology must answer the question: What is the purpose of science and technology? The answer, "for the sake of truth," is not enough.

This question is a thorny one. In times when the goal of lifting people out of poverty and into economic prosperity was readily agreed upon by the public (e.g., 1960s Japan), the conversation was relatively simple. However, today, even if affluence and convenience are the goals, there are diverse opinions on what kinds of states constitute "affluence" and "convenience." In other words, we live in an age in which the answers to the question "What kind of society do we want to live in?" can only be described as diverse.[11]

In recent years, the issue of dual use, which concerns the possible military application of science and technology, has become a major topic.[12] Such issues exemplify the extremely important and controversial question of how to understand the utility of science and technology and in which direction they ought to be applied.[13] As is typical in such cases, the core of the problem concerns how to evaluate the benefits of science and technology for society; identify the resulting ethical, legal, and social issues; and prioritize solutions in situations where there is no right answer. The US tried to solve this issue in the 1970s using

9 For example, see the Inside Higher Ed website at https://www.insidehighered.com/quicktakes/2017/07/26/senate-appropriations-bill-cuts-nsf-fundinghttps://www.insidehighered.com/quicktakes/2017/07/26/senate-appropriations-bill-cuts-nsf-fundinghttps://www.insidehighered.com/quicktakes/2017/07/26/senate-appropriations-bill-cuts-nsf-funding

10 The original text is available online at https://erc.europa.eu/sites/default/files/content/pages/pdf/Vilnius_SSH_declaration_2013.pdfhttps://erc.europa.eu/sites/default/files/content/pages/pdf/Vilnius_SSH_declaration_2013.pdfhttps://erc.europa.eu/sites/default/files/content/pages/pdf/Vilnius_SSH_declaration_2013.pdf

11 This phrase was used by British science advisor Robert May when he summarized the intense social controversy over genetic mo dification technology: "This is not a debate about safety or anything like that. It is about a much bigger question: what kind of wor ld do we want to live in?" (House of Lords, 2000).

12 See Science Council of Japan (2017).

13 For discussions of this issue by the Science Council of Japan, see Science Council of Japan (2012), Science Council of Japan (20 14c).

technology assessment. In fact, Japan is almost the only country in the developed world to not use technology assessment. It is important to reiterate the necessity of addressing this issue.

5 Another role for science and technology

The BSE incident in the UK in the 1990s[14] and the Great East Japan Earthquake and Fukushima nuclear accident in Japan in 2011 have evoked difficult questions about science and technology and political decision-making. The crux of the problem is what kind of advice scientific and technology experts should give in terms of political decision-making in situations where the only scientific knowledge available is uncertain, and how political decision-makers should understand and use this advice.[15]

There is no doubt that science and technology are the most reliable knowledge systems in modern society. As exemplified by medicine, scientific and technological knowledge has made great contributions to our lives. Nonetheless, scientific knowledge is constantly advancing, that is, being updated, and is always accompanied by a host of uncertainties in the present moment. Knowledge like that contained in high school textbooks cannot be so easily revised or rejected. Textbooks contain precisely this kind of knowledge. However, at the cutting edge of research, knowledge is less stable. It is not uncommon for it to be revised every few years. Nonetheless, science and technology experts (i.e., scientists) are sometimes called upon to advise in political decision-making.

For instance, during the BSE incident, there was uncertainty over the cause and the possibility of human infection at the scientific research level. Meanwhile, in other cases, the scientific community has disagreed on issues like predicting developments during the Fukushima accident and the subsequent interpretation of the risks of low-dose radiation exposure. Nevertheless, the question of how to understand, evaluate, and apply uncertain scientific and technological findings to political decision-making is a difficult one. The question of how science and technology experts (e.g., scientists and engineers) should behave in such situations is also a difficult one.

This is where the issue of the objective of science and technology to provide reliable knowledge that contributes to the running of society makes itself apparent. Although scientific justification has its limits, particularly when uncertainty is involved, socially legitimate decision-making is required. The challenge is how to reconcile the legitimacy of knowledge brought by science with the legitimacy of decision-making reached through politics.[16]

As can be seen from the discussion above, as science and technology becomes an essential element in the construction of modern society, it must become ambivalent, producing both revelation and risk. As such, science and technology (e.g., scientists and engineers) cannot escape the ethical, legal, and social considerations present in both aspects. Of course, scientists and engineers must themselves understand this

14 See Kamisato (2005).

15 See Arimoto, Sato, and Matsuo (2016), Science Council of Japan (2014b), Science Council of Japan (2014a).

16 In this regard, the idea of appointing a science advisor, following the example of Europe and the US, was considered following th e Fukushima nuclear accident. However, in practice, this only resulted in the establishment of a science advisor post within the Mi nistry of Foreign Affairs. See Arimoto et al. (2016) for a discussion of issues in this field; also see Jasanoff (2015).

situation, as must society. However, more fundamentally, we must earnestly face the questions of "What kind of society do we want to live in?" and "How can science and technology contribute to this challenge?" As noted, these are essentially the questions that technology assessment confronts.

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Information on related base course subjects and research projects

- STiPS Osaka University, "Introduction to science, technology and innovation policy A" (1 credit, Spring semester)
- STiPS Osaka University, "Introduction to science, technology and innovation policy B" (1 credit, Summer semester)
- StiPS Osaka University, "Introduction to the history and philosophy of science" (1 credit, Summer semester)
- STiPS Osaka University, "Introduction to science, technology and society" (1 credit, Spring semester)

*As of April 2, 2019.