Science and Society: Rights and Responsibilities

ICSU Strategic Review

Strengthening international science
for the benefit of society

ICSU
International Council for Science

About ICSU

Founded in 1931, the International Council for Science (ICSU) is a non-governmental organization representing a global membership that includes both national scientific bodies (103 members) and international scientific unions (27 members).

ICSU's extensive membership network constitutes an international forum for scientific research and policy development.

In broader terms, because of its representative and diverse membership, the Council is increasingly called upon to speak on behalf of the global scientific community and to act as an advisor in matters ranging from ethics to the environment.

ICSU focuses its activities in the following areas:

Planning and coordinating interdisciplinary research to address major issues of relevance to both science and society

Advocating freedom in the conduct of science, promoting equitable access to scientific data and information, and facilitating science education and capacity building

Acting as a focus for the exchange of ideas, the communication of scientific information and the development of scientific standards

ICSU also helps create international and regional networks of scientists with similar interests and maintains close working relationships with a number of intergovernmental and non-governmental organizations.

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Preface

The mission of the International Council for Science is to strengthen international science for the benefit of society. In the light of this mission, it is incumbent upon ICSU to monitor changes at the interface between science and society and to design its activities accordingly. Thus, in 2002, the ICSU General Assembly, which brings together representatives from over 100 countries and 27 different scientific disciplines, requested a strategic review of "Science and Society: Rights and Responsibilities". In so doing, it recognized that there is a dual challenge facing ICSU:

• to define how it can best maintain and develop its traditional contributions to the ethics of scientific practice and Universality;

• to define where and how it can most usefully contribute to broader science and society debates and the communication of science to the public.

This strategic review has been prepared by a panel of independent scientific experts from 12 different countries (annex 1). The panel was tasked with considering the overall context and priorities concerning the science and society interface, as well as specific ICSU activities. Albeit that ICSU itself is considered as representing mainly the 'hard' sciences, it was recognized from the outset of that the social sciences, behavioural sciences and humanities have important roles to play in investigating areas of interaction between science and society. It was also recognized that the systematic study of the interaction has now developed into a cross-disciplinary scientific field in its own right. This was reflected in the choice of panel members, who represent a broad range of disciplines. It is also reflected in the review report itself. Whilst many of the specific recommendations are addressed to ICSU, the analysis of changes in science and society that is described in Section 1, raises many issues which cannot be addressed by ICSU alone. The report as a whole should be of interest to all those concerned with the relations between science and society, including: science funding and policy-making organizations; governments; science communicators; non-governmental organizations; and, individual scientists.

The report as published here represents the views of the independent review panel. It was circulated in draft form to the entire ICSU Membership for consideration and, following amendment, was approved for publication by the ICSU Executive Board in April 2005. In so doing, the Board agreed that the report should be widely disseminated and that many of the important issues that it highlights should, in the first instance, be taken forward in the context of already existing or planned ICSU activities. The board postponed any decision on the Panel's proposal for a dedicated Science and Society Committee. Specific recommendations concerning ICSU will be integrated into the Council's overall strategic plan, 2006-2011, for consideration by the ICSU General Assembly in Suzhou, China in October 2005.

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Executive Summary

The relationship between science and society will centrally influence the directions and practices of science in the 21st century. In order to strengthen science for the benefit of society, scientists need to be responsive to the changing needs and concerns of society; and society, in turn, needs to understand and support the positive role of science. As the move towards a global knowledge economy gathers momentum, with an increasing premium on scientific knowledge and high technology, the time is ripe for a new international initiative that will advance the welfare of science as well as society.

This report, from an international Review Panel, lays out a framework for considering science and society issues and proposes that ICSU take a lead role in addressing these issues at the international level by:
1) extending its remit for ensuring the universality of science, and
2) creating a new interdisciplinary Committee on Science and Society.

A FRAMEWORK FOR CONSIDERING SCIENCE AND SOCIETY ISSUES: FIVE DIMENSIONS OF CHANGE

The relationships between science, technology and society have changed very significantly in recent decades. The most important changes that have implications for the international science community can be grouped under five broad headings:

1. Changes in the mobility and global flows of science and scientists, and associated **challenges to universality**;
2. Changes in the **production of scientific knowledge** and the emergence of hybrid (e.g. public-private) contexts of practice, raising concerns about the impartiality of science;
3. Changes in the speed and scale of innovation, producing unavoidable new **risks and uncertainties**;
4. Changes in the **governance** of science and technology, especially as a consequence of globalization, creating new demands for **expert accountability** and ethical conduct;
5. Changes in the **nature of expertise** on the relations of science and society within civil society, especially among non-governmental organizations (NGOs), and in academia.

Under each of these headings, changing practices and assumptions have revealed inadequacies in existing institutional structures for regulating the relations of science and society. In particular, the self-regulation of science no longer seems adequate to handle all of the pressures placed on scientific integrity. At the same time, national structures alone no longer seem sufficient for ensuring scientific freedom and responsibility at the global level.

The Review Panel has considered each of these five areas and identified a number significant knowledge gaps and needs, which are summarized below. Specific suggestions for possible ICSU actions are highlighted in italics. The panel fully recognized that ICSU does not have the capacity to implement all of these actions and there may be a need for further consultation with its Members to select the short-term priorities.

1. Equity, Access and Universality

The essential elements of the Principle of the Universality of Science as defined in ICSU's statute 5 are non-discrimination and equity. Changes in international relations, including the globalization of trade, the use of new information and communication technologies, and fears over international terrorism are posing new challenges to universality.

How to make universality a reality, taking account of old and new challenges, remains a live question. There is a continuing need ensure the free flow of scientists and scientific information across nations and to strengthen the watchdog functions of organizations such as ICSU that monitor discrimination in science.

There is a growing need to ensure global equity in knowledge production and knowledge sharing[1], including the identification of best practices in contested areas and the development of consensus principles for data access and sharing.

ICSU should play an active role in lowering the entry barriers to science for women and other under-represented groups worldwide. *A primary aim of ICSU should be to enhance the pluralism of science.*

2. Production of Scientific Knowledge

The increasing involvement of the private sector and the close ties to policy making in many areas of research are changing the context in which scientific knowledge is produced.

There is a need to analyze and deliberate on the possible threats to ethics and academic freedom arising from the

new modes of production of scientific knowledge. Information should be developed on the ethical norms and standards that are applied in partnership arrangements for research around the world.

As the corporate sector becomes a more significant sponsor of research, there is a need to monitor and enhance ethical practices within industry. The development and adoption of codes of conduct for scientists and engineers, including those working for industry, remains a priority, as does the sharing of information about such codes.

Peer review and related evaluation practices remain essential, but their roles within changing contexts of scientific practice are poorly understood. These should be systematically monitored and analyzed. Of particular interest are procedures for assuring the quality and integrity of science produced to support public policy decisions in areas such as health, safety and environmental regulation.

The concept of technology assessment needs to be revisited, with regard to: the ethical, environmental, social and economic impacts of technology; cross-national technology transfer; and, the impacts on traditional technologies and other cultural systems. This may require new forms of cross-institutional and cross-disciplinary partnerships. *ICSU may be in a particularly good position to provide leadership with respect to possible assessment models.*

3. Risk and Uncertainty

Science and technology produce not only enormous benefits but also novelties and unknowns that may carry adverse physical, social and ethical consequences. Understanding and fairly communicating risk and uncertainty are increasingly important for science and society.

The treatment of risks and uncertainties in decision-making demands more sustained intellectual analysis and policy attention. Specific questions that should be addressed include:

- How are uncertainties assessed and communicated in diverse areas of decision-making (environment, public health, engineering, terror alerts, disaster forecasts and inquiries, etc.)?
- How effectively is existing knowledge concerning uncertainty, particularly from the social sciences, being deployed in decision-making? Are there any major deficiencies in our knowledge regarding uncertainty or in the uptake of existing knowledge by policy institutions?
- What conceptual and legal frameworks exist for the analysis and communication of uncertainty, how do they differ across disciplines and institutions, and what are their relative advantages and disadvantages? Important examples include risk-based, precaution-based, and evidence-based approaches.
- What ethical standards exist to guide experts in the representation of uncertainty? Are there best practices in diverse areas of risk or uncertainty analysis?
- How do publics cope with uncertainty, and how can decision-makers and the media ensure the responsible communication of uncertainty to publics?

It would be timely for ICSU to convene a series of international workshops/conferences on practices for representing uncertainty in different areas of science and engineering, as well as practices for conveying such uncertainties to decision-makers, the media and the public.

4. Accountability and Governance

The proliferation of risk and uncertainty are increasing the demand for accountability in science. As science and technology pervade more dimensions of life, scientists are also having to be more responsive to societal concerns. There is consequently a need for more participatory and transparent governance mechanisms.

Because it is uniquely representative of the international science community, there is potentially an important role for ICSU to play in relation to the accountability and governance of science. There is a particular need for international forums and processes to discuss these issues.

Mechanisms should be explored for addressing cross-cultural differences in research practice and ethics. *ICSU could promote research and communication on different attitudes towards accountability in science, including dealing with uncertainty and determining 'acceptable risk', in diverse cultural and policy contexts.*

ICSU could promote international dialogue on ethical guidelines and best practices governing:

- Communication between experts and the public;
- Transparency and access in expert advisory processes;
- Journalistic practices for communicating scientific information and related uncertainties.

5. Expertise on Science and Society

The rise of interest and expertise in science-society relations both in civil society and in academia has created new opportunities for effective public engagement and participation in science. Such expertise remains unevenly distributed around the world and procedures for incorporating science-society insights into scientific practice and public policy are poorly developed.

These considerations create a *potential role for ICSU centering on the following issues:*

- Surveying current disciplinary and interdisciplinary approaches to the interaction of science, technology and society; disseminating the findings of such surveys: and enhancing the opportunities for incorporating knowledge concerning science-society relations into research, application and decision-making;
- Identifying and examining methods of accommodating cultural differences, including values and religion, into new areas of science, particularly in the fast-developing domain of biotechnology and genetics;
- Initiating broad-ranging reflection on the communication of science with society. These efforts should go beyond the current primary emphasis on public understanding of science (PUS) and encourage genuine two-way dialogue between scientists and the public;
- Broadening the educational agenda in science, engineering and medicine and exploring mechanisms to engage the next generation of young scientists more effectively in studying and understanding science-society relations;
- Identifying responsible parties and appropriate processes for fostering science-society dialogues in government, industry, universities and other scientific organizations, *including Members of ICSU;*
- Exploring methods of integrating the practices of science and medicine with relevant indigenous, local and traditional cultures and knowledge systems.

DEVELOPING MECHANISMS TO ADDRESS THESE NEEDS

As part of its assessment, the panel reviewed existing ICSU structures and partnerships as they relate to the five key dimensions of change in science and society relations. This has led to a number of recommendations for changes to ICSU structures and activities.

Ensuring the Universality of Science

Science remains a cooperative exercise that thrives on open interaction and international exchange. Although many technological and political obstacles to such exchanges have diminished in recent decades, new barriers have also arisen. Taking these into account, the Review Group recommends:

- *The work of ICSU's Standing Committee on Freedom in the Conduct of Science (SCFCS) on universality remains critically important and should be continued and strengthened;*
- ICSU members should be strongly encouraged to take on responsibility for ensuring and propagating the Principle of Universality at the national and disciplinary levels. To this end, they should work closely with SCFCS, which should provide advice and act as a 'clearing house' for issues and information;
- SCFCS should record and make available to relevant users its experiences in implementing the Principle of Universality.

A New International Initiative on Science and Society

Wide-ranging transformations that have affected the relations between science, technology and society in the past three decades demand an expansion of ICSU's agenda in this area. ICSU's mandate should be to identify emerging problems in the interactions of science and society and to employ its institutional resources and strengths to promote international cooperation in solving these problems.

ICSU should establish a new interdisciplinary Committee on Science and Society, to work with Members and review issues arising at the intersection of science, technology and society and address some of the key issues identified in this report. The Committee should have dedicated executive support and develop the capacity to form partnerships, create independent sub-committees, and raise additional resources in pursuit of specific projects and initiatives. It may be judicious in the first instance to select a small number of significant pilot projects to be developed in partnership with interested ICSU Members.

Partnerships

ICSU has unique strengths in terms of its broad international and interdisciplinary scientific membership, but it should forge new partnerships with other academic disciplines, with the private sector, with policy-makers and with other groups within civil society, in order to have a real impact on science and society issues.

1. Changing Relations between Science and Society

Science and technology are among the most positive forces for change at humankind's disposal. Rising public investments in scientific research, science education, technological innovation and the public communication of science demonstrate that many governments recognize the importance of science and technology for socio-economic development. As the industrial societies of an earlier era evolve into today's high-tech 'knowledge societies', science and technology are regarded as primary drivers of innovation, social welfare, increased productivity and wealth-creation. This presents an enormous challenge to poorer countries who, now more than ever before, need to establish and maintain their own scientific capacities if they are to be competitive in the global knowledge economy. Universal and equitable access to scientific knowledge is crucial in bridging the socio-economic divide between the North and the South. Scientific research and exchange have a central role to play in fostering improved communication and shared orientations to problem-solving across political and cultural boundaries. In a rapidly changing world, the Principle of Universality of Science (ICSU Statute 5, section 2.5.2) provides an important model of equity, non-discrimination and cross-cultural cooperation.

Not all of the impacts of science and technology, however, are equally beneficial, nor are they universally seen to be so. Fears have grown in recent years about the capacity of science and technology to intervene adversely in various dimensions of human life – including its origins, its ending, and its physical and social environments. Advances in genetics and the life sciences are particularly disturbing to many because they not only promise to cure disease and alleviate hunger, but also threaten to irreversibly alter human nature, human relationships and the natural environment[2]. Pollution and physical harm continue to be among the unintended consequences of many beneficial technologies such as electronics, pesticides and vaccines. The increasing dependence on fossil fuel based technologies is changing the planet's climate, with very serious implications for future generations. The application and further development of research with the aim of constructing new and more deadly weapons is still being pursued in several countries. New cooperative understandings between science and society are needed to counter-act these developments and ensure the transition towards more sustainable ways of living [3].

The internet and world wide web have not only brought much of the world closer together but have introduced new vulnerabilities. The role of the media, including their use of new information and communication technologies, is pervasive but their impact on social values and cohesion remain poorly understood[4]. More generally, the speed with which scientific ideas are communicated around the world and are incorporated into technology has increased. The consequences of many technological developments accordingly seem less predictable than ever before.

The political context for doing science also changed radically at the turn of the 21st century, with the end of the Cold War, the intensification of global commerce and communications, and the rise of new transnational threats and conflicts and international terrorism. Closer relations between science and industry, often actively encouraged by governments, have called into question the presumed impartiality of science and the openness of scientific communication. New concerns have also been raised about the ethics of research and the accountability of science to its sponsoring governments and publics, especially as more research is conducted across national political boundaries.

1.1 THE DIMENSIONS OF CHANGE

The most important recent changes in the relations between science and society that have implications for the international science community can be grouped under five broad headings:

1. Changes in the mobility and global flows of science and scientists, and associated challenges to universality;
2. Changes in the production of scientific knowledge and the emergence of hybrid (e.g. public-private) contexts of practice, raising concerns about the impartiality of science;
3. Changes in the speed and scale of innovation, producing unavoidable new risks and uncertainties;
4. Changes in the governance of science and technology, especially as a consequence of globalization, creating new demands for expert accountability and ethical conduct;
5. Changes in the nature of expertise on the relations of science and society within civil society, especially among non-governmental organizations (NGOs), and in academia.

Under each of these headings, changing practices and assumptions have revealed inadequacies in existing institutional structures for regulating the relations of science and society. In particular, the self-regulation of science no longer seems adequate to handle all of the pressures placed on scientific integrity. Many observers have noted ethical strains caused by science's increased dependence on both public and private sector support[5]. There are also growing pressures from government on science to serve specific political ends (Box 1). At the same time, national structures alone no longer seem

sufficient for ensuring scientific freedom and responsibility at the global level.

Frequently, too, national decision-making structures draw on an overly narrow range of expertise with respect to issues affecting science, technology and society. Early UK responses to the 'mad cow' crisis, for example, paid inadequate attention to the knowledge and interests of consumers, farmers and other affected groups, both domestically and internationally[6]. To compensate for such problems at the local level, there is a need for international organizations to participate more actively in the governance of science and technology; there needs to be a dialogue between national and international institutions. International organizations can also play an invaluable role in disseminating knowledge and experience across national boundaries.

The following five sections elaborate on these important changes in the context for doing science and developing technology. Some topics such as the role of the private sector and commercialization appear in several sections as they raise specific issues that are applicable to different aspects of changing science-society relations. Each section presents the background of the problem, sketches the issues raised, and identifies significant knowledge gaps and needs. Actions undertaken by ICSU will have to be designed and carried out against the background of these major developments, issues and needs. Where appropriate, specific potential actions for ICSU are proposed, although it is recognized that there may be a need for further consultation with the Members to define the initial priorities.

1.1.1 Equity, Access and Challenges to Universality[8]

Background

The end of the Cold War has not brought, as some had hoped, an end to concerns about the mobility of scientists and the free flow of science. Rather, traditional threats to mobility and the Principle of Universality continue in many areas of the world in the form of state discrimination against scientists and repression of research and communication. Visa restrictions remain an important barrier to travel and the free exchange of scientific ideas. These problems have been joined by newer concerns arising from persistent social, economic and political inequalities and new transnational measures to protect national competitiveness or guard against terrorism. There have also been disturbing moves within science – either from individuals or groups of scientists or their institutions – to refuse scientific cooperation with their counterparts in other countries for essentially 'political' reasons.

A major area of concern relates to unequal access to scientific information[9]. In theory, the new information and communication technologies (ICTs) have created unprecedented opportunities for including more scientists from economically disadvantaged regions in international research. In practice, several factors sustain a 'digital divide' between richer and poorer nations in relation to ICTs. Countries vary greatly in their capacity to take up new technologies, establish effective communication and publication systems, and pay for data generated abroad. The promise of ICTs for science thus remains unevenly distributed and imperfectly realized around the world.

A further concern relates to the representativeness of science. Despite gains in past decades, women remain underrepresented in the global scientific workforce. Many ethnic and racial minorities are also largely excluded from science. Economic, institutional and cultural barriers hamper entry for these groups in many parts of the world, in both the North and the South. Accordingly, science is less pluralistic in practice than it could be in principle. The lack of equitable representation has serious negative implications not only for society but also, through systematic under-inclusion of some perspectives, for the range and quality of the research that is produced. Many brilliant minds currently have no opportunity to contribute to science.

Issues Raised

The following challenges to the universality of science are particularly significant:

- The unequal distribution of scientific resources and opportunities, particularly between the North and the

Box 1

UNION OF CONCERNED SCIENTISTS CHARGES AMERICAN GOVERNMENT WITH MISUSE OF SCIENCE AND EXPERTISE

On February 18, 2004, the Union of Concerned Scientists (UCS) called upon the administration of President George W. Bush to restore scientific integrity in policymaking. This was the most wide-ranging and highly publicized attack on political bias in the use of science in recent US history. Through a petition signed by 60 prominent scientists, including 20 Nobel laureates, UCS charged the Government with having appointed experts who lacked proper professional competence or had demonstrated conflicts of interest to key advisory committees. UCS also asked the US Environmental Protection Agency to stop the suppression of data relating to public health and to honour congressional requests for disclosure of information. http://www.ucsusa.org/global_environment/rsi/index.cfm. While the Government responded publicly to each of the specific allegations and strongly defended its decisions, there continues to be considerable concern in the scientific community. A subsequent report from the US National Academies has called for more transparency in the process for appointing scientific advisors[7].

South, has created a persistent 'brain drain' from many countries. While some developing countries have been able to reverse the loss of homegrown talent, even to the extent of speaking of a 'brain gain' (e.g., India in software design), the flight of skilled, scientific and technically trained personnel remains a very pertinent issue in other regions.

- The development of the Internet and growth of cyberspace have increased the potential for access to and free flow of information but have also raised new concerns about information quality, privacy and encryption. On the side of greater openness is the emergence of an open source movement providing access to source code for software. There are various initiatives to provide 'open access' to the scientific literature and some commercial publishers are taking steps to improve access to information in poorer countries. On the side of constraints on information flow are uncertain legal rules and inconsistent national standards that affect both the quality and accessibility of science communicated on the Internet.
- Intellectual Property Rights (IPR) are designed to encourage innovation and protect invention, but they also affect access to science and the shape of the 'public domain' for science. There are growing (and to some extent legally recognized) movements to recognize community-based property rights in knowledge, for example, indigenous rights in relation to medically significant biodiversity. Conflicts continue around the interpretation of the Trade Related Intellectual Property's (TRIP's) agreement of the World Trade Organization. Overall, IPR remains a globally contested domain, with considerable scope for conceptual development and legal harmonization.
- New global security issues have arisen, particularly in connection with measures against terrorism. The introduction of stringent visa requirements in the United States, for example, is credited with a marked drop in graduate applications from international students in 2003-2004.
- Basic human rights violations continue in many parts of the world. They have been supplemented by additional pressures on scientific freedom flowing from security concerns, and anti-terrorism measures.
- The status of women in science and engineering remains an issue despite encouraging progress in some fields. There are persistent cross-disciplinary differences in gender representation and regional disparities in women's access to science and engineering education.
- Access to scientific training and knowledge for various ethnic or racial minorities is limited in many countries. While this is often the indirect consequence of other social inequalities, it is a particular challenge for both science and society.
- The growth of research in (or sponsored by) the private sector raises particular questions about the ethics of conducting and communicating science in industry. There is a need to clarify the rights and responsibilities of whistle-blowers who call attention to inappropriate practices.
- Ethical concerns about developments in science have gained prominence in many countries and within international organizations. These have also raised new questions about the quality of ethics training, and about ethics as a possible vehicle for the imposition of dominant values and standards

Knowledge Gaps and Needs

How to make universality a reality, taking account of old and new challenges, remains a live question. There is a continuing need ensure the free flow of scientists and scientific information across nations and to strengthen the watchdog functions of organizations such as ICSU that monitor discrimination in science.

There is a growing need to ensure global equity in knowledge production and knowledge sharing, including the identification of best practices in contested areas and the development of consensus principles for data access and sharing[10].

ICSU should play an active role in lowering the entry barriers to science for women and other under-represented groups worldwide. A primary aim of ICSU should be to enhance the pluralism of science

1.1.2 The Changing Production of Scientific Knowledge

Background

With regard to the production of science, there is increasing awareness that the binary distinction between 'basic' (pure, curiosity driven, university-based) and 'applied' (use- or mission-driven, industry-based) no longer adequately captures the full range and diversity of scientific and technological activities. Much scientific research is of a more hybrid character, and it occupies the region between basic and applied in novel and socially significant ways. Questions for science now seem to come to an increasing degree from the needs or interests of state and society, rather than exclusively from scientists' own curiosity. Academic observers of the research enterprise have described a resulting 'Mode 2' of knowledge production[11] that has to some extent replaced the traditional academic 'Mode 1' approach[12]. This dual mode concept can be criticized for oversimplifying a complex pattern of changes. Nevertheless, it is helpful in highlighting some overall trends in the practice of science.

Thus, Mode 2 can be described by the following characteristics:

– Knowledge is increasingly produced in contexts of application (i.e., an increasing amount of science is to some extent 'applied' science);

– Science is increasingly trans-disciplinary - that is, it draws on and integrates empirical and theoretical elements from a variety of fields;

– Knowledge is generated in a variety of sites, not just universities and industry, but also, for example, in variously supported research centers, consultancies, and think-tanks;

– Participants in science have grown more aware of the social implications of their work and publics have become more conscious of the ways in which science and technology affect their interests and values.

The most salient feature of Mode 2 science, as thus described, is that it is more thoroughly embedded in society than traditional Mode 1 science. This makes science more sensitive to society's needs, but it also generates new problems. The aims, methods, resources, results, and evaluation procedures of science in Mode 2 are all more sensitive to social and political influences than is the case for basic (Mode 1) science[13]. Examples of Mode 2 include research done to clarify issues of major public concern (e.g., environmental problems such as acid rain, biodiversity loss and climate change; global societal problems such as poverty or urbanization; and public health problems such as the transmission of AIDS, SARS and other infectious diseases). Many of these issues are clearly inter-related and can be grouped together under the heading of sustainable development. They require a new truly inter-disciplinary scientific approach[14], including the integration of natural and social sciences; more place–based and participatory methods and integration of science with other knowledge systems.

Mode 2 science also includes science done in response to decision-makers' specific needs; examples include chemical toxicity testing, field trials of genetically modified (GM) crops to assess gene flow, epidemiological studies of worker health, and the development of risk assessment models, simulation models and socio-economic assessments to support a wide variety of regulatory policies.

The conditions of scientific practice in the 21st century include an increasing presence of the private sector, as well as increased collaboration, sometimes mandated by law and policy, among universities, industry and government. While this development has generated more resources for science and strengthened ties between research, development and commercialization, it also carries possible risks to academic freedom and research ethics (Box 2)[15].

These qualitative changes in the practice of science have significantly redefined the relations between science and society. Putting aside the methodological challenges for research, science can no longer be seen as intrinsically pure – if indeed it ever was so - but rather as serving many masters, which raises new questions about its motives, ethics and interests. A major concern is whether peer review – the traditional process used to ensure the integrity of science – needs to be supplemented by additional processes that secure more open communication and effective criticism of scientific results bearing on public health, safety and welfare. The internationalization of science gives particular urgency to issues like these and provides a rationale for active involvement by ICSU.

Issues Raised

Changes in the focus and practice of science raise new issues concerning rights and responsibilities:

- Corporate, private foundation and other NGO involvement in the production of science, raise particular issues about peer review and quality control[18]. For example, there is at present often less control over the review and publication or communication of industry-funded research than research produced in universities (Box 3). On issues such as the risks of tobacco smoking, asbestos disease, and anthropogenic climate change, industry-funded science of questionable quality has served to undermine or discredit consensus positions accepted by the large majority of scientists[19].
- There is increasing concern over conflicts of interest for scientists in universities and government stemming from entanglements between corporate and other science. Many universities have adopted codes of ethics to regulate conflicts of interest resulting from the dual roles of scientists as employees and entrepreneurs. These codes specify the amounts and kinds of private commitments scientists may have consistent with their university appointments. However, even where codes exist, the rules often do not address the broader problem of

Box 2

THE UC BERKELEY-NOVARTIS CASE

An agreement that attracted considerable attention in the international scientific press was a deal struck in 1998 by the giant biotechnology company Novartis with the Department of Plant and Microbial Genetics at the University of California, Berkeley (USA). Under the agreement, the company provided Berkeley $25 million in return for rights to negotiate licenses on roughly a third of the department's discoveries and unprecedented representation on the research committee responsible for overseeing how the money would be spent. The deal became even more controversial when Ignacio Chapela, a member of the contracting department, published in Nature a contested study on gene transfer from bioengineered to native varieties of Mexican maize. Chapela and his co-author David Quist had vocally opposed the Novartis agreement, and many saw the furor over their paper, less as an ordinary debate over methodological flaws than as a vendetta against them for that stance. Berkeley's initial denial of tenure to Chapela in 2003 aroused further concern about academic and scientific freedom.

Box 3

PEER REVIEW AND SELECTIVE PUBLICATION

In June 2004 the American Journal of Psychiatry published the results of a study which had found that the antidepressant medicine Celexa could help children and teenagers diagnosed with depression. The study was sponsored by Forest Laboratories which markets the medicine in the USA. The journal had the article refereed before publication and insisted on financial ties being divulged. However the article failed to mention, even in its footnotes, that a previous major study had found in 2002 that Celexa was not any more effective than a placebo in helping depressed adolescents. That study, sponsored by the Danish company that developed Celexa, had not been published. A group of medical journals and public research funders is currently calling for all drug trials to be publicly registered so that trials that have negative results can be recorded and company scientists are not able to selectively use data that show their products in a favourable light[17].

the privatization of research agendas and the information flowing from them.

- Confidentiality or ownership agreements, often introduced for commercial reasons, can lead to restrictions on publication, which in turn raise issues about responsibility and credit. There is evidence that the proliferation of university-industry agreements has had a negative impact on openness in communicating science[20].
- Excessive privatization may restrict the availability of independent science in 'hot' topical areas, such as cloning or stem cell research in the biomedical sciences. This in turn has potentially grave consequences for the evaluation of research and unbiased advice to governments.
- Ethical standards for publicly and privately funded research also vary in some countries, including the United States, where federally funded research is subject to stricter controls. This raises the possibility of privately sponsored research being conducted in violation of ethical standards acceptable to the majority of citizens and scientists[21].
- Who controls the R&D agenda, particularly in countries or areas where national public funding is scarce? New funding opportunities are providing increased support for North-South networking and research partnerships, but they have also raised issues of control over agenda-setting and equity in the use of research results.
- The ethics of scientific R&D in relation to global trade and development demand greater attention. The international bodies responsible for developing trade policy are not currently structured to deal with these ethical issues.

Knowledge Gaps and Needs

There is a need to collect examples and analyze and deliberate on the challenges to ethics and academic freedom arising from new modes of production of scientific knowledge, as in the Berkeley-Novartis case (Box 2). Information should be developed on the ethical norms and standards that are applied in such cases around the world.

As the corporate sector becomes a more significant sponsor of research, often in partnership with academia, there is a need for an open dialogue on ethical practices within industry. The development and adoption of codes of conduct for scientists and engineers, including those working for industry, remains a priority, as does the sharing of information about such codes.

Peer review and related evaluation practices remain essential, but their roles within changing contexts of scientific practice are poorly understood. These deserve systematic monitoring and analysis. Of particular interest are practices for assuring the quality and integrity of science produced to support public policy decisions in areas such as health, safety and environmental regulation.

The concept of technology assessment needs to be revisited (Box 4) with regard to: the ethical, environmental, social and economic impacts of technology; cross-national technology transfer; and, impacts on traditional technologies and other cultural systems. This may require new forms of cross-institutional and cross-disciplinary partnerships.

Box 4

THE 'TERMINATOR GENE': A CASE OF PUBLIC TECHNOLOGY ASSESSMENT

A major global controversy erupted in 1999 around a move by the multinational Monsanto Company to take over the Delta and Pine Land Company, which had developed and patented a technique that could be used for rendering seeds sterile through genetic modification. If used in agriculture, this technology would have prevented farmers from storing seed from one year and replanting it the following year. An NGO-orchestrated campaign successfully labeled this as the 'Terminator' technology after a popular science fiction film by that name – calling attention to the artificiality of the genetic modification as well as its use to terminate the 'natural' life of seeds. In the event, the company acquisition fell through and so Monsanto never obtained rights on the controversial patent. Nevertheless, under pressure from many fronts, including the President of the Rockefeller Foundation, Monsanto made a public commitment never to commercialize sterile seed technologies. The case may be seen as an example of an *ad hoc* and highly public technology assessment.

ICSU may be in a particularly good position to provide leadership with respect to possible assessment models.

1.1.3 Risk and Uncertainty

Background

Science and technology are universally seen as producers not only of enormous benefits, but also of novelties and unknowns that may carry adverse physical, social and ethical consequences. Indeed, uncertainty seems so pervasive that some academic analysts have argued we are living in a 'risk society', in which everyone, regardless of social and economic status, is always to some degree at risk from advances in science and technology[22]. Technological innovations – from cars to computers, vaccines to genetically modified foods, and nuclear power to nanotechnology – have brought unintended consequences, both positive and negative[23]. Global climate change, a side-effect of industrialization, has raised new concerns about long-term risks, intergenerational equity and the potential for disproportionate harm in the poorest countries and sectors of society. Globalization of trade has helped to magnify these concerns. Communication and free trade may raise worldwide levels of welfare, but they also create inequities in the distribution of risks and benefits. This results both from the growing distance between producers and users and from the fact that hazards, such as those linked to climate change, tend to affect the poor disproportionately more than the wealthy. These features have rendered inadequate the system of regulatory checkpoints through which national authorities historically controlled risks: through expert predictions; technically grounded regulatory standards; and insurance or compensation for victims of unavoidable injury or harm.

In the absence of appropriate regulatory mechanisms and risk-benefit analyses, there can be a tendency towards excessive caution, which in turn can stifle innovation and/or deprive some sectors of society of the benefits of scientific and technological development. (Box 5).

From ICSU's standpoint, the growing inadequacy of national procedures to assess and manage trans-boundary risks is significant. It implies that there is a need for international institutions to participate in the identification, analysis and management of cross-border risks (balanced against benefits) resulting from innovations in science and technology. International bodies can play an important role in monitoring risk controversies and disseminating knowledge concerning the conceptual foundations, processes and results of risk assessment and management.

Issues Raised

The prevalence of uncertainty raises many issues concerning science-based decision-making and how to manage or mitigate risks. The following are particularly significant:

- The role of scientists, balancing risk and uncertainty, in providing advice for policy, especially on global and transnational issues such as climate change, demands increased attention. There is a need for greater cross-cultural understanding about the nature and responsibilities of expert bodies and the appropriate roles of individual experts. The effects of time and resource limits on the participation of experts from different national and institutional settings also need to be considered. Practices and procedures for increasing transparency and participation in expert decision-making deserve closer study, and the costs and benefits of alternative approaches need to be better understood.
- The growing use of models as instruments for policy analysis and decision-making raises important questions of standards and professional ethics (Box 6). Ethical issues in predictive modeling and uncertainty include divergent value judgments and assumptions guiding the production and use of models. Some branches of philosophy have begun to explore the foundations of uncertain knowledge and statistical inference and the results merit more debate across all scientific disciplines. Of particular interest are different professional standards regarding the representation of uncertainty in models and the transparency and accessibility of such representations. Of interest too are the practices of experts in various disciplines in communicating their uncertainties to peer groups, the media, politicians and the public.

Box 5

RISK, REGULATIONS AND ACCESS TO VACCINES

Occasionally the price to pay for greater certainty, as enshrined in global 'gold standards' for risk reduction, may be too high for poor countries. One example is the increasingly strict regulations for Good Manufacturing Practice (GMP) in relation to drugs and vaccines. In the 1990s many small national producers were forced to close because of their inability to cope with the expenses related to the exigencies of GMP (intentionally developed to improve certainty and to diminish risks, but unintentionally favouring companies with high investment capacity and more expensive products). This accelerated the replacement of older and cheaper vaccines that were no longer patent-protected with newer ones that were patent-protected and many orders of magnitude more expensive. In some countries vaccination coverage diminished, exposing the population to increased risk of disease. This broader risk was not accounted for in the risk-benefit analysis that originally led to the universal imposition of very strict GMP guidelines.

Box 6

ENGINEERS AND UNCERTAINTY

In 1990 Engineers Australia produced a discussion paper entitled "Are you at Risk? Managing Expectations" arguing that if people were more aware of the uncertainties surrounding engineering work and the limitations of mathematical models they would not so readily blame engineers for failures. It pointed out that engineers had presented a falsely optimistic and idealistic view of their work and were now paying the price for inflated public expectations.
"We know (or should know) that our models are limited in their ability to represent real systems, and we use (or should use) them accordingly. The trouble is that we are so inordinately proud of them that we do not present their limitations to the community, and leave the community with the impression that the models are precise and comprehensive." The dilemma for engineers and scientists today is how to tell the public of the extent of their ignorance without losing the community's confidence[24].

- Legal and policy prescriptions regarding transparency and openness, including peer-review, vary across cultures. Some decision-making systems subscribe to the view that expert deliberations should be closed to the public in order to encourage more open sharing of uncertainties among experts. Others hold that uncertainties are more fully disclosed and discussed if the public has complete access to expert deliberations and even to the data and information underlying their judgments[25]. Such cross-national and cross-cultural differences and their implications deserve further study and discussion.

Knowledge Gaps and Needs

The treatment of risks and uncertainties in decision-making demands more sustained intellectual analysis and policy attention. Specific questions to be addressed include:

– How are uncertainties assessed and communicated in diverse areas of decision-making (environment, public health, engineering, terror alerts, disaster forecasts and inquiries, etc.)?

– How effectively is existing knowledge, particularly from the social sciences, concerning uncertainty being deployed in decision-making? Are there major deficiencies in our knowledge regarding uncertainty or in the uptake of existing knowledge by policy institutions?

– What conceptual and legal frameworks exist for the analysis and communication of uncertainty, how do they differ across disciplines and institutions, and what are their relative advantages and disadvantages? Important examples include risk-based, precaution-based, and 'evidence-based' approaches.

– What ethical standards exist to guide experts in the representation of uncertainty? Are there best practices in diverse areas of risk or uncertainty analysis?

– How do publics cope with uncertainty, and how can decision-makers and the media ensure the responsible communication of uncertainty to publics?

It would be timely to convene a series of international workshops/conferences on practices for representing uncertainty in different areas of science and engineering, as well as practices for conveying such uncertainties to decision-makers, the media and the public.

1.1.4 Accountability and Governance

Background

With regard to accountability, both the greater responsiveness of science to social concerns and the proliferation of risk and uncertainty have given rise to new demands for citizen participation in defining the goals and purposes of scientific research and development[26]. These demands have led to much experimentation with new forms of participation: for example, referenda, citizen juries, the inclusion of Major Groups from civil society in UN summit dialogues, consensus conferences and other public deliberative processes (Box 7). They have pushed global organizations such as the World Bank to reconsider their funding policies and to adopt new methods of environmental assessment. Numerous international treaties and agreements have recognized the need to include holders of local, indigenous and traditional knowledge in treaty implementation[27]. A plethora of new bodies, of various composition, have been formed to discuss the ethics of new technologies in different countries. These have multiplied in the past decade in connection with genetics and biotechnology, but comparable developments are also occurring in relation to other 'hot' areas, such as nanotechnology.

National forums and processes provide useful models (Box 8), but they offer only partial solutions to worldwide demands for accountability in science and technology. For example, the internationalization of scientific research has created uncertainty about the applicable principles of informed consent in clinical trials and research involving human subjects; should the same principles be universally applicable across all countries?[28] Controversies like these cannot be solved solely through nation-specific rules or guidelines. The products of science and technology are reaching wider markets, crossing national borders and having an impact on the global environment. Nationally based deliberations concerning the goals, forms, risks and benefits of innovation seem inadequate to meet the demands of global citizens.

There is a general concern about the decrease of trust

Box 7

UK DELIBERATION ON GENETICALLY MODIFIED CROPS

In 2003, the British government responded to widespread consumer distrust of genetically modified (GM) crops and foods with an unprecedented exercise in public deliberation. The effort deserves attention as a novel experiment in democratic governance and also raises particular issues about who represents the public[30]. No debate of this magnitude had previously been conducted on the introduction of a novel technology. The process consisted of three strands in three separate institutional settings, all overseen by the Secretary of State for the Environment, Food and Rural Affairs. One strand was a study of the costs and benefits of GM crops conducted by the Prime Minister's Strategy Unit. The second was a Science Review headed by Sir David King, the government's Chief Science Adviser. The third was a public debate called 'GM Nation'. The debate was overseen by a steering board drawn mainly from the Agriculture and Environment Biotechnology Commission, the expert advisory body that had advised the government to organize such a consultation. The debate revealed considerable similarities in expert and non-expert judgments concerning the uncertainties, although not the associated relative risks, of commercializing GM crops. The UK Government eventually moved forward with a cautious decision to commercialize some crops, but this decision was much narrower than approvals for commercialization granted in other countries, including the USA.[31]

in institutions, including both government and industry. Although public surveys often indicate high trust in science in the abstract, there is considerable distrust of scientific information produced by industry and to some extent also by government agencies[29]. Globalization may intensify the loss of trust by increasing the distance between producers and users of knowledge; for example, safety assessments done in an exporting country may carry little or no credibility in importing countries with different traditions of expert advice and public participation (Box 9). The transmission of knowledge across cultures with different expectations about privacy, consent, transparency and professional integrity raises additional questions and conflicts.

Issues Raised

The breakdown of trust and pressure for greater transparency point to a set of issues concerning science-society relations:

- Many professional scientific organizations are urging their members to play a more active role in communicating their research results and their significance to the public. Unlike professional communications within science, however, these exchanges are not controlled by processes of peer criticism or review. The increase of direct communication between science and the public raises serious questions about the quality, objectivity and accuracy of information made available by scientists to the publics interested in or affected by their research.
- The news media today are major sources of public communication about science and technology. Yet the responsibility and accountability of journalists in the popularization of science, engineering and medicine remain largely matters for individual media sources to decide for themselves. Similarly, there is little systematic knowledge or understanding of the standards by which scientists and other experts regulate their communications with the mass media.
- Consumer advertising raises further ethical concerns about the communication of scientific and technical information. Problems are likely to intensify with growth in public advertising of pharmaceutical drugs, novel foods, alternative medicines and other 'life improving' products.

Box 8

DANISH CONSENSUS CONFERENCES

Democracy has long been seen in Denmark as being dependent on citizens being well-educated and politically engaged. This is referred to as "people's enlightenment" or folkeplysning. The Danish consensus conference involves a panel of laypeople becoming informed about a topic, listening to a variety of experts and writing a report that reflects the consensus they have reached about the topic. The idea of the consensus conferences is to find out how a well-informed community would view particular technological developments or issues. The lay panel is chosen to reflect a broad cross-section of society, taking account of gender, geographical location, education, and occupation. The consensus conferences are reported to be a great success. Some have resulted in new legislation, and the reports are widely quoted in parliamentary speeches and in journal articles. They are also heavily covered by the media, raising public awareness of issues and influencing political discussion. They demonstrate that lay people can understand complicated issues if they are interested and are given the time to become informed [32].

- Uses of biobanks and other databases of biological materials for research and policy purposes (e.g., criminal DNA data banks) have generated novel ethical dilemmas (Box 10). Important questions center on the rules relating to privacy; individual, family and group consent; ownership of information and materials; future uses of data; and most broadly of governance[34].

- Developments in international science in areas such as agricultural biotechnology are raising new questions concerning global scientific governance: who governs and under whose agenda? This is especially relevant in contexts where there is high scientific uncertainty and low consensus on values. However, it also applies to topics, such as climate change, where there is very substantial scientific evidence with major socio-economic implications. These questions have particular international salience because comparative research has shown that countries vary greatly in the values and judgments they apply to assessing uncertainty in policy-relevant science. A particular area of conflict and misunderstanding has emerged around risk-based versus precaution-based approaches to the assessment of regulatory science (see 1.1.3).

Box 9

CROSS-CULTURAL SCIENCE AND TECHNOLOGY CONTROVERSIES

There have been many recent episodes of rejection by national governments or publics of scientific claims of safety produced in other countries. These include France's reluctance to import British beef even after UK compliance with EU regulations concerning 'mad cow' disease; European unwillingness to import GM crops and foods based on US assurances of no risk; and the refusal of some African governments to accept food aid in the form of GM grain. These episodes point to the lack of trust in risk assessment and regulatory science as a major, and possibly growing, international problem for science and society.

Knowledge Gaps and Needs

Because it is uniquely representative of the international science community, there is potentially an important role for ICSU to play in relation to the accountability and governance of science. There is a particular need for international forums and processes to discuss these issues.

Mechanisms should be explored for addressing cross-cultural differences in research practice and ethics. ICSU could promote research and communication on different attitudes towards accountability in science, including dealing with uncertainty and determining 'acceptable risk', in diverse cultural and policy contexts (see also 1.1.3).

ICSU could work with other key stakeholders to promote international dialogue on ethical guidelines and best practices governing:

– Communication between experts and the public;
– Transparency and access in expert advisory processes;
– Journalistic practices for communicating scientific information and related uncertainties.

1.1.5 Expertise on Science and Society

Background

With regard to expert understanding of the relations of science and society, there have been significant developments in civil society as well as in academia in recent decades. On a wide variety of social issues – e.g., environment, fisheries, and sustainable development – Non-Governmental Organizations (NGOs) have emerged as independent sources of valuable local knowledge, supplementing the expertise of mainstream science. NGOs representing marginalized groups, such as women, children and indigenous peoples, have successfully contributed their knowledge and insights to national and international decision-making bodies like the World Bank and the World Commission on Dams (Box 11). Following the 1992 United Nations Earth Summit in Rio de Janeiro, which included a separate Global Forum for non-governmental participants, NGOs have participated extensively in local activities designed to promote sustainability at the community level.

Teaching and research on science and society have also grown in importance during the past two decades. Academic institutions throughout the world have introduced new ethics curricula for engineering and medical students. Bioethics has emerged as a recognized field of study and substantial research programs on the ethical, legal and social implications of the human genome project have been established in many countries.

More generally, programs of education and training in science, technology and society (STS) have been introduced at many universities. Sometimes organized

Box 10

CONFIDENTIALITY AND USE OF BIOLOGICAL SAMPLES

In investigating the murder of the Swedish minister of foreign affairs, Anna Lindh, in 2003 the police obtained a sample of blood of a main suspect from a bio-bank at a university hospital in Stockholm. This bank was established in the mid 1970s, and contains 3 million samples of blood from newly born children. It is used mainly to trace five different diseases that may lead to severe disabilities if they are not detected early, as well as for research. It is still unclear whether it was legally permitted to supply the sample to the police. Such use was not included in the original consent agreements with parents. The sample provided strong evidence that the suspect was the murderer and led to his arrest. At the subsequent trial he was found guilty. This case has led to strong criticism from many parents and others against the hospital. There is an urgent need to clarify the legal situation on restrictions on the use of bio-banks if potential future donors are not to be discouraged from supplying biological samples for research[33].

as free-standing interdisciplinary units and sometimes embedded in traditional disciplines such as history or anthropology, these programs provide formal training in STS to undergraduates, doctoral students and postdoctoral fellows. Such programs focus on the relationship of science and technology to other social and political institutions, such as courts, administrative agencies, social movements or patient groups.
STS work has attained visibility through the field's professional journals and societies. STS has also become, to some degree, a source of policy advice to governmental and corporate decision-makers.

Box 11

THE NARMADA DAM CONTROVERSY

In 1993, the World Bank withdrew its support for the Narmada dam project, India's most controversial river valley development plan. Massive protests spearheaded by an environmental group, Save the Narmada Movement, called attention to the plight of people to be displaced by the project and cited numerous environmental and public health concerns that they felt had been inadequately addressed by government experts[35]. The Narmada controversy was one episode that motivated the formation of the World Commission on Dams, an international body that has sought to establish more immediate contacts between global planning processes and the citizens affected by such projects.

Issues Raised

Recognition that valuable 'expertise' exists outside the scientific community and the emergence of science-society relations as an independent field of scholarship and action raise important issues for science:

- Knowledge and awareness about the consequences of scientific and technological development are now widely distributed in society. Scientists have no monopoly on evaluating the ethical implications of their work. Nor do scientists necessarily have the knowledge or capacity to forecast the full social implications of innovation. Given the distributed character of expertise on science and society, where does the social responsibility of science end, and what is the role of other actors in assessing the impacts and consequences of scientific and technological change?
- Past attempts to communicate science to the public were usually founded on a 'deficit model' that represented the public as ignorant and needing to be enlightened through top-down communication by experts. Recently, awareness has grown of the need for a more robust image of citizens and publics, as knowledge generators, critics and users. This in turn calls for the development of more flexible processes of two-way dialogue and communication[36].
- Scientists most frequently communicate with the public through a variety of intermediate institutions: the media, government agencies, courts, expert commissions, etc. These institutions often operate with simplified and incomplete pictures of the scientific enterprise and/or of the nature of science-society relations. Increasing the overall level of social competence on science-society relations thus requires communication with major institutions that are in regular interaction with science.
- Globalization of technologies, e.g. in agriculture and medicine, has highlighted the importance of understanding science-society relations from divergent cultural perspectives. Such understanding is essential in order to appreciate the striking variations in cross-cultural receptiveness to innovation.
- Responsibility for the conduct of science and for effective communication concerning science's aims and objectives is shared today by a variety of organizations, corresponding to changes in the production of scientific knowledge outlined in Section 1.1.2. These organizations include universities, research centers, government labs and industry. It would be desirable for all these knowledge generating institutions to widen their sensitivity to science-society relations and improve their capacity for analyzing and debating these issues.

Knowledge Gaps and Needs

The rise of interest and expertise in science-society relations both in civil society and in academia has created new opportunities for effective public engagement and participation in science and technology. At the same time, such expertise remains unevenly distributed around the world and institutional channels for incorporating science-society insights into scientific practice and public policy are poorly developed.
These considerations create a potential role for ICSU centering on the following issues:

– Surveying current disciplinary and interdisciplinary approaches to the interaction of science and society; disseminating the findings of such surveys; and enhancing the opportunities for incorporating knowledge concerning science-society relations into research, application and decision-making;

– Identifying and examining methods of accommodating cultural differences, including values and religion, into new areas of science, particularly in the fast-developing domain of biotechnology and genetics;

– Initiating broad-ranging reflection on the communication of science with society. These efforts should go far beyond the exclusive emphasis on public understanding of science (PUS) and encourage genuine two-way dialogue;

– Broadening of the agenda in science, engineering and medical education and exploring mechanisms to engage the next generation of young scientists more effectively in studying and understanding science-society relations;
– Identifying responsible parties and appropriate processes for fostering science-society dialogues in government, industry, universities and other scientific organizations, including Members of ICSU;
– Exploring methods of integrating the practices of science and medicine with relevant indigenous, local and traditional cultures and knowledge systems[37].

2. ICSU and Ethics, Rights and Responsibilities

In addition to defining a framework for considering science and society issues and identifying some key issues where actions from ICSU might be merited, the Review Panel carried out an assessment of ICSU's major recent and ongoing activities in this area.

2.1 BACKGROUND

A major responsibility for ethics is implicit in ICSU's mission – 'strengthening international science for the benefit of society'. ICSU plausibly has a role to play with respect to both the ethical aspects of scientific practice and the ethical responsibility of science and scientists in a broader societal context. The former, which relates mainly to the internal functioning of science and the rights of scientists, is an area in which ICSU has substantially contributed in the past. Since its inception, ICSU has vigorously pursued a policy of non-discrimination and equity in science, as embodied in the Principle of the Universality of Science. However, as discussed in the previous section of this report, it is the area of 'science and society' more broadly that is likely to provide the greatest challenges to scientists in the future. This is not, to date, an area in which ICSU has been very active.

2.2 DEFINING ICSU'S REMIT

At the outset of the strategic review, the panel identified several key principles in relation to ICSU's remit for ethics, rights and responsibilities:

1. The major strengths of ICSU, as an institution, in dealing with these issues are the non-governmental, international and interdisciplinary nature of its constituency.

2. ICSU should be guided by a coherent longer-term strategic framework and should not be sponsoring highly specific *ad hoc* or time-limited activities unless they are directly relevant to its strategic vision.

3. An equitable partnership between social and natural sciences is critical both in the development and implementation of ICSU's strategy in this area.

4. In order to have an impact at the policy level, the relationship with intergovernmental agencies, such as UNESCO, is important.

5. If ICSU is to address some of the key 'science and society' issues effectively, then both its traditional academic base and its non-academic partnerships need to be broadened.

In considering future activities, it was also recognized that new mechanisms may be necessary to ensure that ICSU builds on the strengths of its membership and forms the appropriate partnerships.

2.3 ICSU MEMBERS AND ETHICS

National Members of ICSU are mainly science academies or national interdisciplinary funding agencies. These organizations are variable in structure and capacity but most of them have some involvement with science policy development at the national level. This includes a responsibility for the professional conduct of the national scientific community and, for example, the establishment of good practice guidelines and resolution of cases of misconduct. Some National Members also have extensive 'science and society' and/or science education activities. These include the organization of public debates and/or issuance of reports on key issues of public concern, such as the risks of vaccinations, genetically modified organisms (GMOs), mobile phones or nanotechnology. What characterizes most of these activities is their predominantly national focus and perspective. While most National Members focus on natural sciences, mechanisms exist in many countries to ensure collaboration with social sciences and humanities, engineering and medicine.

The International Scientific Unions, which represent a broad range of disciplines from crystallography through to geography, also vary in size and capacity. The traditional role of the Unions has been to strengthen their own disciplines internationally, although the interaction with other scientific disciplines and society more widely is gaining increasing emphasis. Unions have a strong interest in, and responsibility for, professional conduct within their individual disciplines and many have their own ethics committees or commissions. With a few notable exceptions (history and philosophy of science, anthropology and ethnology, psychology), they represent mainly the natural sciences; the relative weakness in social sciences is an important consideration in relation to the science and society issues identified in the previous section of this report.

Because of their extensive links to the international research community, the Scientific Unions are ideally positioned to identify emerging scientific developments that raise ethical issues. As part of its ongoing strategy development process, ICSU consulted its entire membership – Unions, National Members and its Interdisciplinary Bodies in 2003 to try and identify such emerging scientific issues. This led to the identification of several major themes, ranging from sustainable development to cognitive neuroscience[38], which are potential areas for ICSU activity in relation to ethics. It is notable that the interface between science and society and the need to integrate both social and natural science perspectives was identified by many ICSU Members as a very high priority.

2.4 ICSU COMMITTEES WITH A SPECIAL RESPONSIBILITY FOR ETHICS

The main way that ICSU initiates activities is to establish Policy or Advisory Committees and Interdisciplinary Bodies (IBs). The former, as their name suggests, are responsible for the development and management or monitoring of specific areas of science policy; they have a limited remit and report directly to the ICSU Executive Board. IBs are more varied in nature. They normally combine operational and policy/advisory roles in relation to a specific scientific area: they are established by the Members but are financially and legally independent.

Until recently, ICSU had two Policy Committees, whose main remit was 'ethics': the Scientific Committee for Responsibility and Ethics in Science (SCRES) and the Scientific Committee for Freedom in the Conduct of Science (SCFCS). The former committee was disbanded at the 27th ICSU General Assembly in September 2002, in the light of the decision to conduct the current strategic review. SCFCS continues to function but its future role is one of the principal issues for consideration in the current review.

There are also a number of other ICSU Interdisciplinary Bodies that have or had some responsibility for ethics. Principal among these was the Advisory Committee on Genetic Experimentation and Biotechnology (ACOGEB), which was also disbanded at the 27th General Assembly. It was noted at the Assembly that the important 'science and society' issues relating to biotechnology and genetics should be considered as part of any strategic review of ICSU's future role in this area

2.5 ASSESSMENT OF SPECIFIC ICSU ACTIVITIES AND PARTNERSHIPS

2.5.1 The Assessment Process

A detailed evaluation of past ICSU activities was not within the remit of the current forward-looking strategic review. However, it was considered important to analyze past experience in terms of the lessons to be learnt and the successful and unsuccessful actions that might accordingly be continued or disbanded.

With these perspectives in mind, several guests who had been closely involved in past ICSU activities and partnerships were invited to discuss their experiences with the Review Panel at its second meeting.
A summary of these discussions and consequent recommendations is given below.

2.5.2 Universality: SCFCS and Human Rights

The Chairman of the ICSU Standing Committee on Freedom in the Conduct of Science (SCFCS), Peter Warren (UK) and one of its key members Carol Corrillon (USA) made oral presentations to the Review Group. Ms. Corrillon is also the Executive Director of the Committee on Human Rights of the US National Academy of Sciences and Director of the International Human Rights Network of Academies and Scholarly Societies.

ICSU STATUTE 5

"The Principle of the Universality of Science is fundamental to scientific progress. This principle embodies freedom of movement, association, expression and communication for scientists as well as equitable access to data, information and research materials. In pursuing its objectives in respect of the rights and responsibilities of scientists, the International Council for Science (ICSU) actively upholds this principle, and, in so doing, opposes any discrimination on the basis of such factors as ethnic origin, religion, citizenship, language, political stance, gender, sex or age. ICSU shall not accept disruption of its own activities by statements or actions that intentionally or otherwise prevent the application of this principle."

Revised wording approved by the ICSU Executive Board, December 2004

SCFCS

SCFCS is an ICSU Policy Committee that was created in 1963. At the time of this review SCFCS had 6 members and 2 *ex officio* members, including the ICSU Secretary General and Executive Director. The committee normally meets twice per year and is serviced by a dedicated Executive Secretary supported by the Swiss Academy of Sciences. ICSU direct support is ~$20,000 *per annum*.

The essential elements of the Principle of the Universality of Science as defined in ICSU's statute 5 are non-discrimination and equity. Coincident with the present strategic review, SCFCS had been conducting its own review of this principle; the outcome is summarized in the document "Universality of Science in a Changing World: ICSU's role". This document (Annex 2) contains a number of suggestions as to potential future responsibilities for ICSU and how these might be implemented and managed. It was considered as an important contribution to the review panel's deliberations on SCFCS specifically and universality more broadly (section 1.1.1).

The threats to the Universality of Science are many-fold and SCFCS recommended that ICSU play a more visible and proactive policy and management role in the future. This role should expand beyond the historical preoccupation with visa restrictions for ICSU meetings. In order to achieve this, individual ICSU members would have to accept clear responsibility and implement appropriate mechanism(s) for ensuring the Universality of Science. Stronger links and improved information exchange would be required of members. ICSU has an important advisory role to play as the central 'clearing

house' and 'corporate memory', and in ensuring exchange of best practices across its membership.

Science and Human Rights Networks

SCFCS has in the past involved itself in a number of cases of human rights violations against scientists who were being persecuted principally because of their scientific activity. Where individual scientists are repressed for other reasons, such cases have tended to be dealt with by the Committee on Human Rights (CHR) that was established by the US National Academy of Sciences in 1976. This committee is still hosted and supported by the Academy, although there is some uncertainty about its location and financing in the longer term. The CHR also acts as secretariat for the International Human Rights Network of Academies and Scholarly Societies which was created in 1993 and has over 60 affiliated national members, some of which have, or are now establishing, their own human rights committees. The aim of this Network is to assist scientists and scholars around the world who are subjected to severe repression, including imprisonment, solely for having non-violently exercised their rights as promulgated in the Universal Declaration on Human Rights. In practice, this involves intensive case work, high-level missions and visits and petitions. As a last resort, petitions can be filed by the Network with the UNESCO Committee on Conventions and Recommendations, which deals with individual cases in strict confidentiality. The Network generally has more than a dozen petitions before the UNESCO committee at any one time.

In addition to cases of imprisonment of scientists, the CHR and the Network are increasingly being solicited to become involved in a number of other issues relating to human rights and the rights and responsibilities of scientists and to produce public statements on issues ranging from female genital mutilation to embargoes on scientific publication and threats to academic freedom and the independence of academies. It was stated to the Review Panel that ICSU support would be appreciated on these more general human rights issues. The other major burgeoning area relates to visa restrictions for scientists traveling to and from the USA. While this latter problem is being addressed by the USA national scientific community and its representative bodies, it was seen as important that ICSU, as an independent international body, continue to monitor the situation closely and provide public support and assistance as necessary. (It was noted by the Review Panel that, while there are new and very significant problems relating to visas for the USA, similar problems also persist in many other countries.)

Recommendations / Lessons Learnt

i. *The work of SCFCS on Universality remains critically important and should be continued and strengthened.* SCFCS should be reconstituted (and possibly re-named as the "Universality of Science Committee"), with an expanded mandate that covers both policy and management issues relating to the Universality of Science, as proposed in the document "Universality of Science in a Changing World: ICSU's role" (Annex 2). In this regard, careful attention must be paid to ensuring the dedicated secretariat function and appropriate membership for this committee in the future. In particular, there is a need for PR/communications expertise.

ii. ICSU members should be strongly encouraged to take on responsibility for ensuring and propagating the Principle of Universality at the national and disciplinary levels. They should work closely with SCFCS in this enterprise, with the latter providing advice and acting as a 'clearing house' for issues and information.

iii. SCFCS should find means to record and make available to relevant users its experiences in implementing the Principle of Universality. There is considerable accumulated experience, within both SCFCS and the NAS CHR and Network, of breaches of universality and human rights. It would be timely for these bodies to carry out a statistical analysis of anonymized case records in order to inform future policy discussions.

iv. The current system of cross-membership between SCFCS and the NAS Committee on Human Rights is crucial to ensuring the appropriate synergy between these bodies. Careful attention must be paid to ensuring the continuity of this relationship in the future.

v. The uncertain longer-term funding situation for the CHR and fragility of the nascent International Human Rights Network are a cause for concern. ICSU should monitor this situation carefully and make appropriate interventions should the situation deteriorate.

vi. The increasingly important role of the private sector in relation to Universality, e.g. in relation to conflicts of interest and information sharing, was noted. The re-constituted SCFCS should explore how it might develop links with private sector science.

2.5.3. Responsibility and Ethics in Science

The former chairman of ICSU's Scientific Committee on Responsibility and Ethics in Science (SCRES), Matthias Kaiser, provided input to the review. At its final meeting in September 2002, SCRES had been asked to identify important issues that it considered appropriate for ICSU activity in the future and lessons that should be learnt from its own experience. The outcome of this 'self analysis' was also provided to the Review Panel.

SCRES

SCRES was established as an ICSU policy committee in 1996, with a broad remit:

– To act as a focus within ICSU and with outside

partners for questions pertaining to scientific responsibility;

– To clarify issues of moral principle which affect the choice of priorities for scientific research;

– To raise awareness of important ethical issues among scientists, policymakers and the public.

The Committee had four full members and two *ex-officio* members, the ICSU Secretary General and Executive Director, and it worked in close liaison with SCFCS. Its activities were supported by a full-time Executive Director, who was hosted in the Norwegian Academy of Sciences with additional financial support (~$80,000 *per annum*) being provided via the Research Council of Norway.

SCRES carried out two major activities between 1996 and 2002. The first was the organization of a special session on Responsibility and Ethics in Science at the World Conference on Science (WCS, Budapest,1999). This was a joint activity with UNESCO-COMEST (see 3.1, ahead). The second activity was a follow-up to the WCS involving an empirical study of over a hundred existing standards of ethics in science[39]. In addition to these 'core' activities, the Executive Director and individual members of SCRES participated in various meetings and other activities on behalf of ICSU/SCRES.

Recommendations / Lessons Learnt

i. The SCRES mandate was very broad and, in retrospect, too ambitious for one small Policy Committee.

ii. SCRES never succeeded in identifying a particular niche relative to the activities of individual ICSU members. It was handicapped from the outset in being a small committee with very few contact points to the member organizations of ICSU. The mechanisms for networking with ICSU members and communication with the ICSU Executive Board need to be carefully considered for any future ICSU activities in this area.

iii. SCRES and SCFCS had over-lapping remits. While the former ostensibly dealt with responsibilities and the latter with rights, in practice it was difficult to separate these areas. Thus ICSU had two Policy Committees with some redundancy in their roles.

iv. The structure and organization of SCRES - a small committee that met annually, with a relatively independent secretariat acting between meetings - was not ideal. For any new initiative, a more flexible structure that facilitates better links with the diverse community of researchers actively working in the field of ethics and responsibility in science would be more appropriate. Any secretariat/administrative function would ideally be embedded in an active multi-disciplinary research environment, where it could draw upon on-going work. In order to carry out substantive work, it is also likely that external resources would need to be obtained for individual projects.

v. The awareness raising role of SCRES with regard to the general public was never addressed. This was partly a consequence of the overly broad remit and the structural and organizational issues described above, but it is also related to the global scope of most ICSU activities. Many science and society issues tend to be context specific and are more easily tackled at a disciplinary level or through local, national or regional initiatives. If ICSU is to play an active role in this area, then effective networking with its own members and appropriate partners will be very important.

3. Partnerships

It was recognized by the Review Panel at the outset, and reinforced during their work, that many organizations beyond the immediate ICSU family have invaluable expertise and experience in science and society issues. Although it was not feasible to consider all of these organizations in detail, it was clear that collaboration with appropriate partners that have expertise and perspectives different from, but complementary to, those of ICSU is essential.

Two organizations were explicitly considered as part of this review. UNESCO, which is inter-governmental, has historically been a partner for ICSU in relation to science and ethics. Pugwash, a network of concerned scientists, has also historically had links with ICSU and was reflecting on its own future strategy at the time of this review. In addition, a preliminary list, including a brief profile, of other potential partner organizations has been compiled by the Review Panel (see Annex 3).

3.1 UNESCO

UNESCO is a key inter-governmental partner for ICSU in many areas of science and has two dedicated ethics bodies whose activities are of direct relevance to this strategic review: the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) and the International Bioethics Committee (IBC). UNESCO's ethics activities are embedded in the Social and Human Sciences Sector with an overall focus on promoting empirical research and philosophical reflection and developing international standards. Dr Henk ten Have, the Executive Director of the UNESCO Ethics division provided an overview of the division's activities and future plans at the second meeting of the Review Panel.

COMEST

The World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) is a committee of 18 independent members that was established in 1998. It has a broad remit with its initial activities being in the diverse fields of water, energy, space and the information society. Its future focus will be on environmental ethics and exploring the feasibility of developing a generic code of conduct for science. The activity on the ethics of space will also be developed further.

ICSU is represented on COMEST and, prior to this review, the ICSU Executive Board had been exploring the possibility of a joint initiative in the area of environmental ethics. A proposal for a joint project on the precautionary principle was declined by the ICSU Executive Board in 2003 and COMEST is now proceeding alone in this area. At the time of this strategic review, there was one limited ongoing joint activity on 'Ethics and Responsibility in Research training', looking at how issues of ethics should be incorporated into the training of young scientists. A further project to look at the feasibility of establishing a code of conduct for scientists, somewhat similar to the Hippocratic Oath for clinicians, was also under discussion. Both of these projects were directly related to key recommendations from the ICSU/UNESCO World Conference on Science in 1999 for which COMEST and SCRES (see 2.5.3) had worked together.

International Bioethics Committee (IBC)

The International Bioethics Committee is a group of 36 appointed independent experts established in 1993. It was supplemented in 1998 by an elected Inter-governmental Bioethics Committee (IGBC) which oversees the IBC activities and assesses its reports before they are considered by all UNESCO member states. Several other UN agencies also have their own ethics committees and, in 2002, an interagency committee on bioethics was established to ensure coordination between these and other international bodies, such as the Council of Europe.

The initial focus of IBC was genetics and it was responsible for the Universal Declaration on the Human Genome and Human Rights in 1997. An International Declaration on Human Genetic Data was subsequently developed and agreed in 2003. IBC has now expanded its mandate and had been charged with developing a Universal Declaration on Bioethics.

ICSU was formerly represented on IBC by the Chairman of SCRES and, coincident with this review, was being consulted for contributions to the proposed Declaration on Bioethics.

Overall UNESCO Strategy

The activities of both COMEST and IBC could be divided into three distinct categories:

– standard-setting: declarations and codes of practice;

– capacity building: education, workshops and training, establishment of a global observatory;

– awareness raising: rotating conference series.

The potential interest and role of ICSU in working in partnership with UNESCO was considered in relation to each of these categories.

RECOMMENDATIONS / LESSONS LEARNT

i. As an inter-governmental body with direct links to national policy-makers, UNESCO is in many ways an attractive partner for ICSU on issues relating to science and society. Closer coordination of ICSU and UNESCO activities, e.g. in relation to universality, is to be encouraged and collaborations with COMEST and IBC should be established on a

'case by case' basis. In any collaborative project, the role of ICSU as an independent representative of the grass-roots scientific community should be protected.

ii. ICSU should not normally play a proactive role in UNESCO's universal 'standard setting' activities, which are mainly the purview of governments. While there may be some merit in Universal Declarations in specific areas, these can only be of a very generic nature and hence have limited impact on the actions of individual scientists. ICSU should encourage the self-regulation of science and the implementation of existing codes of practice that are context specific. (One possible exception to this is the joint commitment made by ICSU and UNESCO at the World Conference on Science to develop a 'Hippocratic Oath' for scientists. The desirability of such an oath, which is likely to vary from one country to another, should be fully explored with the ICSU membership before any subsequent steps are taken.)

iii. ICSU, via its membership, should play a major role in awareness raising and capacity building with regard to 'professional ethics' and good scientific practice. There is considerable scope for exchange of best practices within the ICSU family. The development of a Global Ethics Observatory by UNESCO is an important initiative in this regard. ICSU should explore with UNESCO how it might best contribute to this observatory.

iv. In developing projects in relation to science and society, the potential added value of collaborating with UNESCO should be explored on a case by case basis. COMEST has already conducted youth forums and the policymaker focus of UNESCO may also be very relevant to particular projects.

3.2 PUGWASH

Pugwash is one of the best known international organizations with regard to the social responsibilities of scientists. Several members of the Review Panel and many other scientists associated with ICSU have participated in an individual capacity in activities of the Pugwash organization. The Review Panel, on the basis of members' individual experience and knowledge, considered the merits of Pugwash as a potential partner for future ICSU activities. It should be noted that there was no formal consultation with Pugwash as part of the review.

The mission of the Pugwash Conferences on Science and World Affairs is to bring scientific insight and reason to bear on threats to human security arising from science and technology in general – and, above all, from the catastrophic threat posed to humanity by nuclear and other weapons of mass destruction. Pugwash was started in 1957 and has established a worldwide network of eminent scientists, scholars and individuals experienced in government, diplomacy and the military. While the scientific emphasis is on natural sciences, the Pugwash membership includes many political scientists and also an active students' group.

The original focus of Pugwash was science for peace - the threat of nuclear war and the role of science in that regard. With the end of the 'cold war', its interests have diversified and at the time of this strategic review, Pugwash was reviewing its own future role. It had established a working group on science, ethics and society, which was exploring issues similar to those outlined in the current report

From ICSU's perspective, the potential added value of working with Pugwash includes its complementary membership and outstanding reputation. Given the developing common interest of the two organizations in relation to science and society, there appears to be considerable potential for future partnerships on specific projects.

3.3 OTHER PARTNERS

A number of other potential partners were identified by the Panel during this review and an initial list is given at Annex 3. In addition to identifying partners for its own activities, ICSU should be receptive to proposals for collaboration from other organizations where these are consistent with the strategic vision and framework laid out in this report. The report should be distributed to all those organizations listed at Annex 3 with an invitation to consider how they might work with ICSU in the future.

4. A new International Initiative on Science and Society

Bringing together the issues and challenges described at the outset of this report, and combining them with the assessment of existing ICSU activities and partnerships, the Review Panel concluded that, in addition to strengthening its work in relation to universality, significant changes are necessary if ICSU is to have a genuine impact on science and society. ICSU's mandate in this area should be to identify emerging problems in the interactions of science, technology and society and to employ its institutional resources and strengths to promote international cooperation and equity in addressing these problems. To take on this challenge, ICSU will require:

– a mechanism through which to respond to the Review Panel's analysis and recommendations;
– a set of principles or criteria for priority-setting; and
– identification of specific issues and topics on which ICSU and its Members, in partnership with other relevant organizations, can most effectively intervene.

4.1 THE REVIEW PANEL RECOMMENDS:

A Mechanism

ICSU should establish a new Committee on Science and Society, with an initial five-year lifespan, to review issues arising at the intersection of science, technology and society and to work with Members and partners to address some of the key issues identified in this report (Section 1). The Committee should have dedicated support and the capacity to form partnerships, create independent sub-committees, and raise additional resources in pursuit of specific projects and initiatives. (See Annex 4 for a draft of the Committee's proposed structure and remit)

Principles for Priority Setting

In selecting issues for action by ICSU, the Committee should be guided first and foremost by ICSU's unique strengths and mission 'to strengthen international science for the benefit of society'. This in turn means that priority should be given to issues and topics

- With a major international dimension;
- Which present particular opportunities for dissemination of important information and lessons learnt from one national or regional context to others;
- Which offer significant possibilities for interdisciplinary cooperation (especially between natural and social sciences and humanities) and/or bring together different perspectives on science, technology and society;
- Where intervention by ICSU would be especially timely and is likely to lead to wide uptake of results with significant social benefits;
- Where other national or international bodies have not already taken the lead and are adequately covering the subject;
- Where significant possibilities exist for productive partnerships with other organizations and/or stakeholders in science and society.

Issues and Topics of Concern

Many issues on which ICSU can make an important contribution have been identified in section 1 of this report. Such issues fall into two major categories:

I) matters affecting science and society of significant concern to science in general and to all members of the ICSU family;

II) matters relevant to particular areas of scientific practice where significant ethical or social conflicts have arisen or are likely to arise.

This report has focused mainly on the more generic issues in the first category. The identification and subsequent exploration of issues related to specific scientific developments in category II absolutely depends on strong interactions between the proposed committee and ICSU member organizations. Annex 4 includes a preliminary list of potential issues (in both categories I and II) arising from the panel's deliberations. A simple strategic framework for consideration of such issues can be developed by adopting the 5 broad themes that are proposed in Section 1 of this report.

4.2 CONCLUDING REMARKS

Through its international membership and dedication to the Principle of Universality, ICSU is uniquely positioned to play a catalytic role with regard to many contemporary issues arising from the interactions of science, technology and society. However, ICSU's present organizational structure is inadequate for the broad and vigilant attentiveness called for in this area. It is essential for ICSU to develop an institutional capacity for working closely with its Members to monitor and effectively intervene on issues affecting the ethical and accountable conduct of international science in relation to society. There are substantial intellectual and practical challenges to overcome, but the time is ripe for a thoughtfully proactive international initiative that will advance the welfare of science as well as society.

Annexes and Footnotes

Annexes

ANNEX 1 - TERMS OF REFERENCE

1) To define ICSU's role and responsibilities with regard to:

i) the ethical aspects of scientific practice,
ii) ethical issues concerning science and society and
iii) ensuring the Principle of the Universality of Science[40];

2) to advise the Executive Board on future priorities for science and ethics, taking into account the CSPR[41] activities to define new scientific priorities;

3) to advise on mechanisms and structures to address these priorities most effectively;

4) to consider whether partnerships with other bodies and representative groups beyond the ICSU family should be established.

Membership of Review Group

CO-CHAIRS:

Professor Bengt Gustafsson[42], Uppsala, Sweden (astrophysics)

Professor Sheila Jasanoff, Harvard, USA (science and public policy)

MEMBERS:

Professor Sharon Beder, Wollongong, Australia (S&T and society)

Professor James Dooge, Dublin, Ireland (hydrology)

Professor Quiheng Hu, Beijing, China (engineering)

Dr. Yadon M Kohi, Dar es Salaam, Tanzania (Law and medicine)

Dr. Monica Konrad, Cambridge, UK (social anthropology)

Professor Norbert Kroo, Budapest, Hungary (physics)

Professor Deborah Mayo, Virginia, USA (philosophy)

Professor Omar Masera, UNAM, Mexico (ecology)

Professor Jaraslova Moserova, Prague, Czech Republic (medicine)

Professor Indira Nath, New Delhi, India (medicine)

Professor Moises Wasserman, Colombia (biochemistry)

Brief Biographies of Review Group members

Sharon Beder, Professor of Science, Technology and Society at the University of Wollongong, is author of several books including The Nature of Sustainable Development, The New Engineer, Global Spin, Selling the Work Ethic and Power Play. She has been Chairperson of the Environmental Engineering Branch of the Institution of Engineers, Sydney, President of the Society for Social Responsibility in Engineering, and a director of the Earth Foundation. In 2001 she was presented with the World Technology Award in Ethics.

James C. I. Dooge is Emeritus Professor of Civil Engineering at University College Dublin and Past President of the Institution of Engineers of Ireland and of the Royal Irish Academy. He is a foreign member of the Academies of Science of Poland, Russia and Spain and Dalton Medallist of the European Geophysical Union and Bowie Medallist of the American Geophysical Union. He had been awarded the International Prize in Hydrology by the International Association for Hydrological Sciences and the International Prize in Meteorology by the World Meteorological Organisation. He is a former Secretary General and President of ICSU.

Bengt Gustafsson is Professor of Theoretical Astrophysics at Uppsala University. In addition to his works on stellar atmospheres, galactic evolution and nucleosynthesis, he has written on the ethics of research, research policy, science and development, and various other topics. He was one of the initiators of a still active research ethics seminar at Uppsala. He has served in various international bodies, including the International Astronomical Union, and in a number of national Swedish boards, dealing with research financing and research policy. He has been active in collaborations between universities in the Third World and in Sweden. He is member of the Swedish, Norwegian and Danish academies of sciences.

Sheila Jasanoff is Pforzheimer Professor of Science and Technology Studies at Harvard University's John F. Kennedy School of Government. She has held academic positions at Cornell, Yale, Oxford, Kyoto, and the Science Center in Berlin. At Cornell, she founded and chaired the Department of Science and Technology Studies. She has been a Fellow at the Berlin Institute for Advanced Study (Wissenschaftskolleg) and Resident Scholar at the Rockefeller Foundation's study center in Bellagio. Her publications center on the role of science and technology in the legal and policy systems of modern democratic societies. They include The Fifth Branch (1990), Science at the Bar (1995), and Designs on Nature (2005). She has served on the Board of Directors of the American Association for the Advancement of Science and as President of the Society for Social Studies of Science.

Monica Konrad is a social anthropologist and directs the research group 'PLACEB-O' (Partners Linked Across Collaborations in Ethics and the Biosciences – Orbital) at the University of Cambridge, UK. Her research addresses the relevance of contemporary anthropology for global governance in science, international ethics, and interdisciplinary studies. She is the author of books on the new reproductive and genetic technologies, a member of the current Nuffield Council on Bioethics Working Party on 'The ethics of prolonging life in

fetuses and the newborn', and sits on the UNESCO working groups on nanotechnology and space science.

Yadon Kohi is a Professor of Medicine with research interests in infectious diseases. He is also training in Law. He is director-general for the Tanzania Commission for Science and Technology and a member of the Global Forum for Health Research.

Norbert Kroo is Professor of Physics and former managing director of the Research Institute for Solid State Physics and Optics of the Hungarian Academy of Sciences. He is currently Secretary General of the Hungarian Academy and a member of the Councils of Academia Europaea and the European Science Foundation. He is a member of the ICSU Standing Committee on Freedom in the Conduct of Science (SCFCS).

Omar Raul Masera, Professor of Energy and the Environment, Center for Ecological Research, National University of Mexico (Centro de Investigaciones en Ecosistemas, UNAM). National Contact Point, Pugwash Conference on Science and World Affairs. He conducts interdisciplinary research on the socio-economic and environmental implications of technological change in rural areas. He has written on diverse aspects of the relationships between sustainability, science, technology and society.

Deborah Mayo is a Professor of Philosophy at Virginia Tech, and on the faculty of the Philosophy, and the Economics departments. She received the Lakatos Prize for her book, Error and the Growth of Experimental Knowledge. (Chicago, 1996). She co-edited Acceptable Evidence: Science and Values in Risk Management (with Rachelle Hollander, Oxford 1991). Mayo's work is in the epistemology of science, philosophy of experiment, and foundations of statistical inference. She also teaches special topics courses in Science and Technology Studies, values in science, and economic methodology.

Jaraslova Moserova is a Professor of Medicine and member of the Senate of the Czech Republic. She is a member of the World Commission on the Ethics of Scientific Knowledge (COMEST) and the UNESCO Executive Board.

Indira Nath MD. FRCPath., earlier S N Bose Research Professor of the Indian National Science Academy, Head of Department, Department of Biotechnology, All India Institute of Medical Sciences, New Delhi. Currently, Dean, School of Medicine, AIMST, Malaysia. National positions have included: Foreign Secretary, INSA; Secretary, Society for Scientific Values; Member, Scientific Advisory Committee to the Cabinet. Teaching MBBS, MD, MSc, PhD students; research in Immunology of Infectious Diseases, in particular leprosy.

Hu Quiheng is a Professor of Engineering and former director of the Institute of Automation of the Chinese Academy of Sciences (CAS). She is Vice-President of CAS and President of the Chinese Association for Automation and Chinese Computer Federation.

Moises Wasserman. Chemist, National University of Colombia. Ph.D., Biochemistry Hebrew University of Jerusalem. Researcher on Biochemistry and Molecular Biology of Tropical Parasites. At the present time Dean of the Faculty of Sciences, in the National University of Colombia, and President of the Colombian Academy of Exact, Physical and Natural Sciences.

ANNEX 2 - UNIVERSALITY OF SCIENCE IN A CHANGING WORLD: ICSU'S ROLE

(This document is based on a review of the Principle of Universality that was conducted by ICSU's Standing Committee on Freedom in the Conduct of Science (SCFCS) in 2003. It was written primarily for the national and international members and interdisciplinary bodies of ICSU. Comments and recommendations that are specific to ICSU have been extracted and are highlighted in italics.)

Introduction

Progress in science is made through the world-wide exchange of ideas, information, data, materials, and understanding of the work of others. Science is a co-operative exercise that thrives on open international interaction and exchange. It transcends national boundaries. In this sense, science is universal and when this universality is infringed or impeded it can have serious consequences for science and for society more broadly.

The essential elements of the Principle of the Universality of Science, as defined in ICSU's statute 5, are non-discrimination and equity. In accordance with this principle, all scientists should have the possibility to participate, without discrimination and on an equitable basis in legitimate scientific activities, whether they be conducted in a national, trans-national or international context. ICSU has long promoted this principle, in particular by defending the rights of scientists to freely associate in international scientific meetings.

The world has changed dramatically since ICSU's establishment in 1931, as has the role of science and scientists in it. The international scientific community is much larger and science now has a higher profile across the globe; it is progressing at an ever-accelerating pace; its relationships with society are increasingly complex and often politically charged. The potential for the misuse of science is broader and, arguably, greater and more dangerous than at any time in the past. Political and military conflicts have brought with them prejudicial behavior and constraints on scientific activity which are likely to grow in the future. Enhanced national security measures have led to changes in scientific practice (particularly in the life sciences) and new restrictions on freedom of movement and limitations on the right to publish are being implemented. Some of the compensatory measures that have been introduced in response to these changes, including self-censorship by

scientific publishers, and pre-emptive behavior by scientific organizations to avoid contravening national security regulations, are in themselves a potential threat to Universality.

In this changing international climate, it is important that ICSU continues to promote and defend effectively the Universality of Science. In order to do so, an assessment of the broad issues and of ICSU's responsibilities relative to those of other scientific institutions and individual scientists has been carried out by the Standing Committee on the Freedom in the Conduct of Science (SCFCS)[43].

Threats to Universality

Threats to the Universality of Science take two forms: threats to freedom of association and threats to the freedom to pursue science. The first relates to issues concerned with travel on scientific business and the provision of visas for such travel. The second relates to discrimination or repression for political reasons and to excessive restrictions, constraints and limitations on normal scientific practice.

1. Threats to freedom of association

Traditionally, through SCFCS, ICSU has promoted Universality through interventions in cases of unreasonable delays or outright denials of visas to individual scientists requesting exit or entry visas to attend ICSU affiliated scientific meetings and/or to engage in legitimate scientific activity. Cases involving visa problems, particularly those based on country of birth, residence, or citizenship; religion, ethnic origin, and or field of scientific expertise, are increasing in some countries and are likely to have a significant impact on science.

- Comment from SCFCS:
ICSU is well versed in the most constructive ways in which individual visa problems for attending scientific meetings can be addressed and redressed and procedurally this is time consuming but reasonably straight forward. However, the scale of the problem goes beyond ICSU affiliated meetings and presents a major challenge to the whole international science community.

2. Threats to the freedom to pursue science

2.1 Discrimination or Repression for Political Reasons

On occasions, ICSU has learned of groups or institutions or governments who refuse scientific cooperation with individual scientists or scientific institutions solely to make a political statement about the policies of the government of the country in which the scientist or institution being discriminated against is located. There have also been instances when scientists, as a result of their scientific activities, publication of their scientific findings, or expression of their scientific opinions, are no longer able to pursue their scientific work because they are victims of repression, including, on occasion, imprisonment and torture.

- Comment from SCFCS:
Intervention by ICSU on a case by case basis can have considerable impact. However, such cases tend to be complex and there are no strict criteria as to how and under what circumstances they should be addressed. For example, repression of an individual (who happens to be a scientist) is not within ICSU's remit although persecution because of being a scientist or because of scientific activities certainly is.

2.2 Excessive Restrictions, Constraints, and Limitations on Normal Scientific Practice

A new set of issues that ICSU is increasingly being asked to consider relates to constraints on scientific practice. This includes restrictions imposed on security grounds that can hinder the normal pursuit of science and Universality. Such issues include:

- Prejudicial recruitment practices and personnel screening
- Restrictions on registration provision and use of scientific equipment, materials and data,
- Constraints on/or censorship of scientific information and the publication of scientific results.

These issues are complex and, for example, may manifest themselves as cumbersome or time-consuming procedures and regulations that are imposed on previously accepted practices. They may come to the attention of ICSU because of their affect on individual scientists but they also have broader policy implications. In either situation, they will involve judgments as to appropriate balance between the freedom to pursue science and institutional, national and international policy imperatives. In order to ensure this balance at the policy level they require a dialogue between the scientific community and governments.

- Comment from SCFCS:
The specific role(s) for ICSU and its members, particularly national members, in addressing each of these developing issues needs to be determined on a case by case basis but active monitoring of the changing international climate for science and its effect on Universality (discrimination and equity) should be a priority. Early action is normally more effective than intervention at a later stage.

Division of Responsibilities for Safeguarding the Universality of Science

Issues relating to freedom of association have an inherently international nature and, where they concern ICSU affiliated meetings, they have traditionally been the responsibility of ICSU and SCFCS. In contrast, issues relating to freedom in the pursuit of science are more often national in origin and in some cases are more appropriately dealt with at regional or national levels.

Upholding the Universality of Science in the light of the new issues that are described above implies extended responsibilities for ICSU, its members and the whole international scientific community. If ICSU is to continue to play a central and influential role, it will need to work closely with its members to: strengthen its monitoring of potential or actual breaches of Universality and its understanding of the more complex issues; to put into place specific mechanisms through which these constraints can be considered and evaluated in terms of Universality and, if deemed appropriate, constructively addressed, in a timely manner, and on a case-by-case basis. ICSU, in addition to its own actions, will need to encourage a commitment to promotion of Universality by the scientific community world-wide and at all levels – from the international to the individual. While ICSU can directly address breaches by its members, it is not in a position to address those committed by individuals. Members need to accept their responsibility to work with ICSU to promote Universality. When breaches are encountered members have a responsibility to help resolve them and/or bring them to the attention of ICSU.

- Comment from SCFCS:
In re-assessing the nature and meaning of the Universality of Science in a changing world, SCFCS proposes changes in the way it functions in future and makes the following proposal for consideration and discussion within the ICSU family.

ICSU should consider maintaining one or more committees/networks and establishing links with other bodies inside and outside the ICSU family to ensure a broader role in defence of Universality. In addition to continuing efforts to defend the free circulation of scientists and of scientific materials and information, future actions for such a committee/network might include:

- *monitoring new situations, new attitudes, and new breaches of Universality and advising the Executive Board accordingly;*
- *identifying where early action would be effective;*
- *taking direct action or providing to the ICSU Board an analysis of the situation and suggested (perhaps incremental) steps that could be taken;*
- *conducting private and well-informed discussions with bodies inside and outside science;*
- *providing the ICSU family with continuing policy advice on Universality;*
- *promoting educational and awareness programmes about Universality, either directly or through others;*
- *ensuring that the shared responsibility for Universality within the ICSU family is well coordinated;*
- *retaining and maintaining the institutional memory of ICSU on Universality;*
- *raising the profile of Universality and ICSU's enhanced role.*

(expanding its base of expertise so as to play a stronger role in contributing to the solution of societal problems in which science is but one element in their resolution)[44]*;*

ANNEX 3 - PRELIMINARY LIST OF POTENTIAL ICSU PARTNER ORGANIZATIONS, RE. SCIENCE AND SOCIETY ACTIVITIES

N.B, this is not a fully comprehensive or exclusive list and there are many other organizations that could be valuable partners for specific activities. The examples listed should only be regarded as illustrative of the type of partners envisaged, by the Review Panel, for various ICSU activities in relation to Science and Society.

ICSU member organizations (see section 2.3 of report)

ICSU members are essential partners and potential co-sponsors for science and society activities that might be envisaged by a new ICSU Committee on Science and Society.

Many ICSU National Members, such as the Royal Society (UK) the National Academy of Sciences (USA) have major science and society programmes mainly focused at the national level.

The International Union of the History and Philosophy of Science (IUHPS) has particular expertise in basic and theoretical ethics including an active division on logic, methodology and philosophy of science (DLMPS).

Several other ICSU Unions have ethics commissions / committees and carry out various science communication activities from their own disciplinary perspective.

ICSU Interdisciplinary Bodies and Joint Initiatives have unique expertise in working across scientific disciplines and cultures in areas of science with direct policy and societal relevance, such as global environmental change.

ICSU Regional Offices

ICSU is establishing four Regional Offices in Africa (NRF, South Africa), Latin America and the Caribbean, Asia & Pacific and the Arab Region.

The ICSU Regional Offices can play a critical role in identifying and exploring specific regional concerns, re. Science and Society. They are also potential co-sponsors and hosts for such activities.

Intergovernmental

The link with policy-makers at the international level is crucial for many issues.

UNESCO: COMEST, IBC, Science sector and Regional Offices (see section 3.1 of report)

The Council of Europe was established in 1949 to defend human rights, European democracy and the rule of Law in Europe. In this context it is concerned with the ethics of scientific practice and science and society issues at a trans-European level. A particular focus has been bioethical issues including healthcare and new genetic technologies.

International Science Organizations

ICSU has well established links with a number of international science organizations, some of whom are scientific associates, and many of whom are potential partners in Science and Society activities. The organizations listed below were identified by the panel as having a particular interest and expertise in this area

Pugwash (see section 3.2 of report)

The International Social Science Council (ISSC), founded in 1952, is a non-governmental organization representing the social sciences at the global level, with 60 member organizations, including national and regional social science bodies, as well as international professional associations of major disciplines.

The Society for Social Studies of Science is the primary scholarly association devoted to the study of science and society. With over 1000 members, it is both interdisciplinary (sociology, anthropology, economics, political science, etc.) and international. The annual meetings and publications of the association are devoted to understanding (1) the processes that generate scientific and technological knowledge and (2) their interaction within social, political, and cultural contexts.

The International Council for Philosophy and Humanistic Studies (ICPHS) is a non-governmental organization, which federates hundreds of different learned societies in the field of philosophy, humanities and related subjects.

The International Network of Engineers and Scientists for Global Responsibility (INES) is an independent non-profit-organization concerned about the impact of science and technology on society. INES' efforts focus on disarmament and international peace, ethics, justice and sustainable development. INES represents over 90 diverse organizations from different countries and is affiliated with the United Nations.

Local and Regional Science and Society Networks / Organizations

There are many local and regional organizations with an active interest in science and society issues, who might add value and introduce new perspectives to particular ICSU activities

The Third World Network is a non-profit network of organizations and individuals interested in economic, social and environmental issues surrounding Third World development. It conducts research, publishes books and magazines, organizes seminars and represents Third World points of view in fora.
http://www.twnside.org.sg/twnintro.htm

The Union of Concerned Scientists is a US-based coalition of scientists and citizens who are committed to "build a cleaner, healthier environment and a safer world". They conduct research into issues such as genetically engineered crops and global warming and advise the media and government.
http://www.ucsusa.org/

Charles Leopold Mayer Foundation for the Progress of Humankind is a Paris-based none governmental organization that brings together academics and interested citizens groups to address issues related to ethics, development and governance in a global context. It has particular interest on the role of science in society.
http://www.fph.ch

Commonwealth Scientific and Industrial Research Organization is an Australian organization partially funded by the Australian federal government. It has a "Social and Economic Integration Emerging Science Initiative" which is staffed and resourced and has included workshops on scientific ethics and science and society issues.
http://csiro.au

The Loka Institute, based in Washington, is a non-profit research and advocacy organization concerned with the social, political, and environmental repercussions of research, science and technology. Loka works to make science and technology more responsive to social and environmental concerns by expanding opportunities for grassroots, public-interest group, everyday citizen, and worker involvement in vital facets of research, science and technology decision making, advocacy and implementation.
http://www.loka.org

Dag Hammarskjöld Foundation established in 1962 and based in Sweden, is an autonomous institution carrying out its own work programs to promote international cooperation for social, political, economic, environmental and cultural development in the South and globally. This is done through the organization of seminars, conferences and workshops, and through publication and dissemination of the material arising from these seminars.
http://www.dhf.uu.se

Centre for Science and Environment is a non-profit public interest organization based in India "which aims to increase public awareness on science, technology, environment and development. Although some of its work focuses on India it also takes part in debates on international issues such as global warming.
http://www.cseindia.org/

The International Institute for Environment and Development is a non-profit London-based institute interested in global issues that affect sustainability. It achieves its goals through collaborative research, policy studies and dissemination of knowledge. It "works with and through a global network of partners and advisors consisting of hundreds of individuals and institutions."
http://www.iied.org/aboutiied/index.html

The Science and Development Network aims to enhance the provision of reliable and authoritative information on science- and technology-related issues that impact on the economic and social development of developing countries. It does this mainly via a free-access website, but also by building regional networks of individuals and institutions and by organizing capacity-building workshops and other events in the developing world.
http://www.SciDev.net

Private Sector

Several key issues have been identified in this review where the role of the private sector is critical and where any ICSU actions must incorporate industry perspectives.

International Chamber of Commerce is the broad umbrella organization that represents industry in UN fora. It is based in Paris and has an active Commission on Business and Society that deals with ethical issues.

World Business Council for Sustainable Development is a coalition of around 170 private corporations which seeks to achieve sustainable development through economic growth, technological innovation and corporate social responsibility.

An increasing number of multinational companies such as Shell are being proactive in developing strategies for sustainable development including 'codes' for ethical practice.

Major International Non-Governmental Organizations (NGOs)

Many major international non-governmental organizations that might not normally be considered as scientific nevertheless have considerable expertise and/or experience on science and society issues. Examples include:

Amnesty International campaigns for human rights around the world. As part of this work it undertakes research and publishes reports.
http://www.amnesty.org/

Friends of the Earth is a network of autonomous environmental groups based in 68 countries that is interested in many science based issues including genetic engineering, cloning, pesticides, pollution, climate change, etc. Friends of the Earth International is based in Amsterdam.
http://www.foei.org/

World Wildlife Fund for Nature (WWF) is an independent foundation based in Switzerland with a network of local Offices and thousands of individual members around the world. It fosters global partnerships and coordinates international campaigns in nature conservation.
http://www.panda.org

The World Conservation Union (IUCN) is the world's largest conservation network. The Union brings together 82 States, 111 government agencies, more than 800 non-governmental organizations (NGOs), and some 10,000 scientists and experts from 181 countries in a unique worldwide partnership.
http://www.iucn.org

ANNEX 4 - COMMITTEE ON SCIENCE AND SOCIETY: PROPOSED REMIT AND STRUCTURE

Objective of Committee

The main function should be to work with the ICSU member organizations and Regional Offices to develop and implement a workplan to address the issues raised in the strategic review report 'Science and Society: Rights and Responsibilities'. More specifically, it should monitor, analyse and initiate appropriate action on important issues concerning the relationship between science and society. The committee should be broadly based and should establish liaison with UNESCO and other specialised UN agencies, other relevant Intergovernmental Bodies, Non-governmental Organisations and the private sector.

Nature of Committee

To incorporate the expertise necessary to address science and society issues, the membership of the committee should include persons drawn from the natural and social sciences and humanities and from the range of key stakeholders concerned with the relationship between science, technology, the private sector and the public policy. The necessary compromise between broad representation and efficient operation of the committee would suggest a membership of nine to twelve persons.

Dedicated executive/secretariat support will be necessary in order to support the committee in the establishment and implementation of its work programme, including liaison with partners and the procurement of funding for specific projects. This executive might be best located in an institution that already has an active science and society programme.

Terms of Reference

The terms of reference should include (a) to provide a focus within ICSU and a liaison capacity for co-operation with outside partners in relation to science and society issues; (b) to work with ICSU members to raise awareness within the science community and amongst other stakeholders of key issues at the interface between science and society; (c) to develop and implement mechanisms to promote genuine dialogue among all the parties concerned with these issues, and as part of this; (d) to promote the development of mechanisms (where they do not already exist) within ICSU member organisations to address science and society issues.

Funding

'Core' support will be required for the functioning of the Committee and its executive/secretariat. Further, if the committee is to go beyond routine activities and commission special studies, workshops and consensus meetings, external funding will be required from intergovernmental sources (such as the European Commission) and/or from private foundations. ICSU member organizations should also be willing to consider providing support (either financial or 'in kind') for specific projects on a case by case basis.

Potential Issues and Topics to be Addressed

Issues that might be addressed by the Committee, in partnership with ICSU members and other organizations fall into two main categories – generic and specific. Suggestions for each of these categories include:

I. Matters of General Ethical or Societal Concern (see section 1 of review report for details)

- Cross-cultural differences in representing, managing and communicating uncertainty and risks;
- Ethical guidelines or principles governing scientists' communication with the media and public or as experts advising government or other decision-makers;
- The role and conduct of peer-review processes in science;
- Cross-cultural issues in the transfer and/or acceptance of new technologies (e.g., information, biomedicine, nanotechnology, agricultural products);
- Procedures for engaging publics in the development of research priorities and policies in areas such as health and environmental research;
- Rules governing disclosure of funding sources and potential conflicts of interest for scientific publications, advice and communications;

II. Matters Specific to Particular Areas of Scientific and Technological Practice (illustrative examples arising from the Review Panel discussions)

- Rules governing privacy of data stored in biobanks;
- Intellectual property rules for biological knowledge and materials ;
- Ethics of informed consent in cross-national research involving human subjects[45];
- Ethical principles governing the representation of uncertainty in technical modeling domains, such as chemical risk assessment, climate modeling or ecosystems impact assessment.

Footnotes

1 ICSU's role in addressing access to information and the digital divide is considered in depth in Scientific Data and Information: A report of the CSPR Assessment Panel (ICSU, 2004), 42pp. This includes a number of specific recommendations on the re-focusing of ICSU activities.

2 For expressions of these concerns, see particularly Francis Fukuyama, Our Posthuman Future: Consequences of the Biotechnology Revolution (New York: Farrar, Straus and Giroux, 2002), and Jürgen Habermas, The Future of Human Nature (Cambridge: Polity, 2003).

3 J Lubchenco, Entering the Century of the Environment: A New Social Contract for Science, 1998. Science: 279, 491-496

4 Robert D. Putnam, Bowling Alone: The Collapse and Revival of American Community (New York: Simon and Schuster, 2000).

5 Sheldon Krimsky, Science and the Private Interest (Lanham, MD: Rowman-Littlefield, 2003); Daniel S. Greenberg, Science, Money, and Politics: Political Triumph and Ethical Erosion (Chicago: University of Chicago Press, 2001).

6 See the complete BSE ('mad cow') inquiry report at http://www.bseinquiry.gov.uk/.

7 Science and Technology in the National Interest: Ensuring the Best Presidential and Federal Advisory Committee Science and Technology Appointments (2004) National Academies Press.

8 Universality as it relates to science can be variously defined. For the purposes of this document its use is mainly limited to the practices of science itself and the rights of scientists, re ICSU statute 5. Where a broader interpretation is appropriate, 'universality' as opposed to 'Universality' has been used.

9 Issues relating to access to scientific information and the logistical and practical requirements to address the digital divide in science are discussed in detail in "Scientific Data and Information, A Report of the CSPC Assessment Panel" (ICSU, 2004)

10 ICSU's role in addressing access to information and the digital divide is considered in depth in Scientific Data and Information: A report of the CSPR Assessment Panel (ICSU, 2004), 42pp. This includes a number of specific recommendations on the re-focusing of ICSU activities.

11 Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott, and Martin Trow, The New Production of Knowledge (London: Sage Publications, 1994).

12 One well-known characterization of Mode 1 science was provided by the noted American sociologist Robert K. Merton, who said that science was guided by the four distinctive ethical imperatives that set it apart from other forms of social activity: communalism; universalism; disinterestedness; and organized skepticism. Robert K. Merton, "The Normative Structure of Science," in Merton, The Sociology of Science: Theoretical and Empirical Investigations (Chicago: University of Chicago Press, 1973), 267-278.

13 Although there are also many notable instances in history where particular lines of basic scientific enquiry have been repressed and scientific evidence rejected by various political, religious or social groups.

14 See for example, ICSU Series on Science for Sustainable Development, No 1-11, 2002-2003 or Kates et al (2002) Sustainability Science. Science 292, 641-642 . Also, S Funtowicz and J Ravetz (1999) Post-Normal Science – an insight now maturing, Futures 31, 641-646

15 The 1980 US Bayh-Dole Act encourages federally funded research institutions to explore the commercial potential of their results by developing links to the private sector. It allows institutions to seek patents on discoveries and inventions in their own name and receive royalties for their use.

16 Daniel S. Greenberg, Science, Money, and Politics: Political Triumph and Ethical Erosion (Chicago: University of Chicago Press, 2001).

17 Barry Meir, 'A Medical Journal Quandary: How to Report on Drug Trials', New York Times, 21 June 2004.

18 For an analysis of these issues in the US context, see Eyal Press and Jennifer Washburn, "The Kept University," Atlantic Monthly, March 2000, pp. 39-54.

19 Sheldon Rampton and John Stauber, Trust Us, We're Experts: How Industry Manipulates Science and Gambles with Your Future (Penguin, 2000) and; Sharon Beder, Global Spin: the Corporate Assault on Environmentalism (Devon: Green Books, 2002).

20 Sheldon Krimsky, Science and the Private Interest (Lanham, MD: Rowman-Littlefield, 2003).

21 For example, in 2001 the Massachusetts-based company, Advanced Cell Technology, announced it had cloned human embryos. There was considerable public opposition to such research, and no US federal funds were available to support it.

22 Ulrich Beck, Risk Society: Towards a New Modernity (London: Sage Publications, 1992).

23 Sheila Jasanoff, "New Modernities: Reimagining Science, Technology, and Development," Environmental Values 11(3):253-276 (2002); Charles Perrow, Normal Accidents (New York: Basic Books, 1984).

24 Sharon Beder, "The Fallible Engineer," New Scientist, 2 November (1991): 32-36.

25 For a detailed review of differences between the United States and several European countries in this regard, see Ronald Brickman, Sheila Jasanoff and Thomas Ilgen, Controlling Chemicals: The Comparative Politics of Regulation in Europe and the United States (Ithaca, NY: Cornell University Press, 1985).

26 Philip Kitcher, Science, Truth, and Democracy (Oxford: Oxford University Press, 2001); Richard Sclove, Democracy and Technology (New York: Guilford Publications, 1995).

27 Marybeth Martello, "A Paradox of Virtue?: 'Other'

Knowledges and Environment-Development Politics," Global Environmental Politics 1(3):114-141 (2001).

28 Marcia Angell, "The Ethics of Clinical Research in the Third World," New England Journal of Medicine 337:647-849 (1997); Peter Lurie and Sidney M. Wolfe, "Unethical Trials of Interventions to Reduce Perinatal Transmission of the Human Immunodeficiency Virus in Developing Countries," New England Journal of Medicine 337:853-856 (1997).

29 See psci.com.ac.uk for access to various recent surveys of public attitudes to science and technology.

30 Campbell S, Townsend E (2003). Flaws undermine results of UK biotech debate. Nature 425: 559

31 Horlick-Jones et al (2004). A deliberative future? An independent evaluation of the GM Nation? Public Debate about the possible commercialisation of transgenic crops in the UK, 2003 (Understanding Risk Working Paper 04-02). Norwich: Centre for Environmental Risk, pp 1-182.

32 Sharon Beder "Consensus Conferences and the 'People's Enlightenment'" Arena Magazine 60, August-Sept. 2002, p20.

33 Blom N (2004) Should large biobanks be used for other aims than they were collected for, such as for finding a murderer (the PKU affair in Sweden) in, Report on Meeting on Biobanks (Bioteknologinemnda, Oslo) p 26 (in Norwegian and Swedish)

34 See, for example, David Lazer, ed., DNA and the Criminal Justice System (Cambridge, MA: MIT Press, 2004); David E. Winickoff and Richard Winickoff, "The Charitable Trust as a Model for Genomic Biobanks," New England Journal of Medicine 349:1180-1184 (September 18, 2003).

35 Michael Goldman, "Imperial Science, Imperial Nature: Environmental Knowledge for the World (Bank)," in Sheila Jasanoff and Marybeth Long Martello, eds., Earthly Politics: Local and Global in Environmental Governance (Cambridge, MA: MIT Press, 2004), pp. 55-80.

36 For statements of the need for such communications, see UK House of Lords, Science and Society (2000), http://www.parliament.the-stationery-office.co.uk/pa/ld199900/ldselect/ldsctech/38/3802.htm; Sheila Jasanoff et al., "Conversations with the Community: AAAS at the Millennium," Science 278:2066-2067 (1997).

37 ICSU has already done some work in this area, which includes making the important distinction between pseudo-science and valuable traditional knowledge and identifying key principles on which productive partnerships should be developed; ICSU Series on Science for Sustainable Development No. 4: Science, Traditional Knowledge and Sustainable Development, (ICSU, 2002) 24pp

38 Forsight Analysis: Report of the CSPR (ICSU, 2004), 26pp www.icsu.org

39 Final report of SCRES: "Standards for Ethics and Responsibility in Science – an Empirical Study" (ICSU, 2002) see www.icsu.org

40 The Principle of the Universality of Science is enshrined in ICSU's statute 5. The Principle itself was subject to review by SCFCS in 2003 and the broader strategic review was to focus more on the mechanisms necessary to ensure that the Principle is up-held.

41 CSPR: ICSU's Committee on Scientific Planning and Review, which was carrying out a foresight exercise, involving consultation with the ICSU membership, to define emerging areas of science that merit action from ICSU.

42 Professor Gustafsson chaired the first meeting of the review group but due to ill-health was unable to fully contribute to the subsequent part of the review. In his absence Professor Jasanoff took over the chairmanship. Both co-chairs and all panel members have fully endorsed the final review report.

43 Review group members: Peter Warren (Chair), Peter Schindler (Secretary), Carol Corillon, Norbert Kroo, Yuan Tseh Lee, Kan Zhang (all members of the Standing Committee on Freedom in the Conduct of Science), Ana Maria Cetto (Secretary General of ICSU, ex officio), Michel Denis (member, Executive Board, liaison link), and Francis Gudyanga (member of Executive Board and also member of the Standing Committee on Freedom in the Conduct of Science)

44 The Strategic review "Science and Society: Rights and Responsibilities" did not consider it appropriate to expand the remit of SCFCS beyond issues directly relating to the Principle of Universality of Science and instead recommends the establishment of a new ICSU committee on Science and Society

45 Issues relating to data and information collection, management and access, including IPR and ethical issues relating to personal data have also been identified as a high priority for ICSU action in Scientific Data and Information: A report of the CSPR Assessment Panel (ICSU, 2004), 42pp

Acronyms

ACOGEB	Advisory Committee on Genetic Experimentation and Biotechnology
CAS	Chinese Academy of Sciences
CHR	Committee on Human Rights
CODATA	Committee on Data for Science and Technology
COMEST	World Commission on the Ethics of Scientific Knowledge
CSPR	Committee on Scientific Planning and Review
ELSI	Ethical Legal and Social Implications
EU	European Union
GM	Genetically Modified
GMO	Genetically Modified Organisms
GMP	Good Manufacturing Practice
IB	Interdisciplinary Bodies
IBC	International Bioethics Committee
ICPHS	International Council for Philosophy and Humanistic Studies
ICSU	International Council for Science
ICTs	Information and Communication Technologies
IGBC	Inter Governmental Bioethics Committee
INASP	International Network for the Availability of Scientific Publications
IPR	Intellectual Property Rights
ISSC	International Social Sciences Council
IUHPS	International Union of the History and Philosophy of Science
NGO	Non Governmental Organization
PR	Public Relations
PUS	Public Understanding of Science
S&T	Science and Technology
SCFCS	Standing Committee on Freedom in the Conduct of Science
SCRES	Scientific Committee for Responsibility and Ethics in Science
STS	Science Technology and Society
TRIPS	Trade Related aspects of Intellectual Property rights
UCS	Union of Concerned Scientists
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCS	World Conference on Science

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ICSU mission statement

In order to strengthen international science for the benefit of society, ICSU mobilizes the knowledge and resources of the international science community to:

Identify and address major issues of importance to science and society

Facilitate interaction amongst scientists across all disciplines and from all countries

Promote the participation of all scientists – regardless of race, citizenship, language, political stance, or gender – in the international scientific endeavour

Provide independent, authoritative advice to stimulate constructive dialogue between the scientific community and governments, civil society, and the private sector.

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